



Freshwater Water Quality Monitoring Protocol

Version FQ-2013.1, Southeast Alaska Network

Natural Resource Report NPS/SEAN/NRR—2013/651



ON THE COVER

Monitoring instrument in the Salmon River, Glacier Bay National Park and Preserve
Photograph by: Eran Hood/UAS

Freshwater Water Quality Monitoring Protocol

Version FQ–2013.1, Southeast Alaska Network

Natural Resource Report NPS/SEAN/NRR—2013/651

Christopher J. Sergeant¹, William F. Johnson¹, and Sonia Nagorski²

¹National Park Service
Inventory & Monitoring Program, Southeast Alaska Network
3100 National Park Road
Juneau, Alaska 99801

²Environmental Science Program
University of Alaska—Southeast
11120 Glacier Highway
Juneau, Alaska 99801

.

April 2013

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate high-priority, current natural resource management information with managerial application. The series targets a general, diverse audience, and may contain NPS policy considerations or address sensitive issues of management applicability.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report is a minor technical and editorial update to an existing protocol that received formal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from http://science.nature.nps.gov/im/units/sean/FQ_Main.aspx and the Natural Resource Publications Management web site (<http://www.nature.nps.gov/publications/nrpm>).

Please cite this publication as:

Sergeant, C. J., W. F. Johnson, and S. Nagorski. 2013. Freshwater water quality monitoring protocol: version FQ-2013.1, Southeast Alaska Network. Natural Resource Report NPS/SEAN/NRR—2013/651. National Park Service, Fort Collins, Colorado.

Revision History

This freshwater water quality monitoring protocol is labeled with the year of acceptance of formal peer review followed by a sequence number indicating the revision level for that year, beginning with one.

Revision History Log:

Prev. Version ID	Revision Date	Revised By	Changes Made	New Version ID
FQ-2012.1	April 2013	C. Sergeant, W. Johnson	Narrative: minor text updates SOP10: corrected filenames SOP9: rewrite SOP1: pH and conductivity calibration revised SOP3: EcoWatch instructions revised Appendix D: selected parameters may be slightly < 0	FQ-2013.1
-	February 2012	-	Initial version	FQ-2012.1

Contents

	Page
Figures.....	ix
Tables.....	ix
Standard Operating Procedures (SOPs).....	xi
Appendices.....	xi
Abstract.....	xiii
Acknowledgments.....	xiv
1. Background and Objectives	1
1.1 Protocol Synopsis	1
1.2 Hydrologic Setting.....	1
1.3 Purpose of Sampling.....	1
1.4 Rationale for Selecting this Resource to Monitor.....	2
1.5 Measurable Objectives.....	2
1.6 The Value of Monitoring Each Parameter.....	3
1.7 Overview of Prior Water Quality Sampling	4
2. Sampling Design.....	7
2.1 Rationale for Site Selection and Sampling Design.....	7
2.2 Site Selection within each SEAN Unit	7
2.3 Definition of the Sampling Boundaries	9
2.4 Sampling Frequency and Replication.....	9
2.5 Trend and Variability Detection	10
3. Overview of Field Methods	11
3.1 Instrument Selection and Set-up.....	11
3.2 Installation of Monitoring Stations.....	11

Contents (continued)

	Page
3.3 Field Season Preparations.....	12
3.4 Field Operations.....	13
3.5 Data Transmission	13
3.6 End-of-Season Procedures.....	13
4. Data Handling, Analysis, and Reporting	14
4.1 Overview of Information Architecture	14
4.2 Overview of Data Products.....	14
4.3 Overview of Formal Analyses and Reports.....	17
4.4 Dissemination: Accessing the Data Deliverables	17
4.5 Repository: Data Archiving	18
4.6 Deliverable Validation and Certification.....	19
4.7 Data Acquisition: Scheduling Deliverable Creation.....	20
4.8 Managing the Production Environment.....	22
4.9 Metadata Maintenance.....	22
5. Personnel Requirements and Training	23
5.1 Roles and Responsibilities.....	23
5.2 Qualifications.....	24
5.3 Training Requirements	25
6. Operational Requirements	27
6.1 Annual Workload and Field Schedule.....	27
6.2 Facility and Equipment Needs.....	28
6.3 Start-up Costs and Budget Considerations	28
6.4 Protocol Revision Process	30

Contents (continued)

	Page
7. Other Considerations	31
7.1 Expansion of the Existing Program	31
7.2 Adding New Sampling Strategies.....	31
7.3 Integrating Core Water Quality Data with Other Studies and Vital Signs	32
8. Literature Cited	33

Figures

	Page
Figure 1. Monitoring station on the Indian River in SITK	7
Figure 2. Monitoring station on the Taiya River in KLGO	8
Figure 3. Monitoring station on the Salmon River in GLBA	9
Figure 4. Example of sonde pipe installation from the Indian River. The black ABS pipe is anchored to the boulder in the left side of the photo..	12
Figure 5. The SEAN Core Functional Model overview.	15
Figure 6. Freshwater water quality monitoring program deliverable products identified on the three tabs of the program’s main dissemination web page.	18
Figure 7. Sequence of tasks and staff responsibilities used in the SEAN certification process.....	20
Figure 8. Typical sequence of deliverable production.	21

Tables

	Page
Table 1. The SEAN data deliverables provided by the freshwater water quality monitoring program.	16
Table 2. Estimated annual equipment and supply costs for the freshwater water quality monitoring program (updated March 2013).	29

Standard Operating Procedures (SOPs)

	Page
SOP 1: Sonde Operation and Field Procedures	37
SOP 2: Data Evaluation and Grading	61
SOP 3: Uploading and Delivering Monthly Sonde Output Data.....	65
SOP 4: Protocol Revision (FQ_A Creation).....	77
SOP 5: Data Availability (FQ_B Creation)	83
SOP 6: Site Visit Worksheets (FQ_C Creation).....	87
SOP 7: Maintenance Log Images (FQ_D Creation).....	91
SOP 8: Sonde Raw Data (FQ_E Creation)	95
SOP 9: Cumulative Database (FQ_F Creation)	99
SOP 10: Annual Report (FQ_G Creation).....	101
SOP 11: Five-Year Report (FQ_H Creation).....	117
SOP 12: NPStoret Submission (FQ_I Creation).....	131
SOP 13: CSV Data (FQ_J Creation).....	133
SOP 14: Managing the Production Environment.....	139

Appendices

	Page
Appendix A. Monitoring site descriptions and directions	143
Appendix B. File folder layouts.....	145
Appendix C. Program tracking spreadsheet layout.....	149
Appendix D. Deliverable definitions	151

Abstract

Freshwater water quality is an important indicator of aquatic and terrestrial ecosystem health in Southeast Alaska. This long-term monitoring protocol provides the information necessary to implement and sustain a long-term monitoring program, including the context and justification for water quality sampling, description of the sampling methodology, listing of staff roles, and detailed instructions for all aspects of field set-up, maintenance, data collection, storage, analysis, and reporting. Data and report products generated by this program will be publicly available on the SEAN web site. These products will inform park staff, managers, and outside parties of the status and trends of basic water quality parameters, and describe the timing and magnitude of seasonal and annual variation of each parameter.

Each year, from at least May 1 through October 31, water temperature, specific conductance, pH, and dissolved oxygen data will be collected hourly from one river in each SEAN park unit: the Salmon River (Glacier Bay National Park and Preserve), Taiya River (Klondike Gold Rush National Historical Park), and Indian River (Sitka National Historical Park). To capture glacial influence on sediment loading, turbidity data will also be collected in the Taiya River.

Annual and long-term report products are rigorously defined to ensure that future products consistently connect to the program objectives defined in this protocol. Data management procedures, including quality assurance, quality control, and data grading, are implemented to provide a properly archived, high-quality data set that serves as the single authoritative data source for all users.

Acknowledgments

The authors extend their sincere appreciation to people that helped create the Freshwater Water Quality Monitoring Protocol. B. Moynahan provided the original vision and program oversight during the development of this protocol. E. Hood contributed to the protocol and helped establish data collection sites. Input and preliminary data provided by C. Soiseth and C. Murdoch (Glacier Bay), D. Schirokauer and J. Wilbarger (Klondike Gold Rush), and C. Smith and G. Smith (Sitka) have been essential to development of this protocol; the importance of their commitments to the operation and success of this program cannot be overstated. J. Shearer of the Southwest Alaska Network provided peer review input and a framework that helped shape the selected approach. E. Starkey from the NPS Upper Columbia Basin Network spent considerable time discussing his water quality monitoring experience and ideas. We also thank P. Burger (NPS), R. Irwin (NPS), and C. McGee (ADEC) for their helpful peer reviews of the original protocol.

1. Background and Objectives

1.1 Protocol Synopsis

The Southeast Alaska Network (SEAN) is one of 32 National Park Service (NPS) Inventory and Monitoring networks. SEAN comprises three park units: Glacier Bay National Park and Preserve (GLBA), Klondike Gold Rush National Historical Park (KLGO), and Sitka National Historical Park (SITK). Freshwater Water Quality is one of the top-tier “vital signs” prioritized by SEAN for long-term natural resource monitoring based on its natural value and/or their vulnerability to alteration by human stressors (Moynahan et al. 2008).

This document describes the context and justification for water quality sampling, details sampling methodology, and prescribes staff roles and data collection, analysis, and reporting procedures. The Standard Operating Procedures (SOPs) referenced throughout this protocol narrative contain detailed instructions for all aspects of field set-up, maintenance, data collection, quality control, storage, analysis, and reporting. Together, the protocol narrative and SOPs contain the information necessary to implement and sustain a long-term monitoring program.

Components of this protocol were developed with significant methodological contributions from SEAN staff, other NPS monitoring networks, other federal agencies, and instrument manufacturers. Some ideas and step-by-step instructions are derived from the SEAN oceanography monitoring protocol (particularly data management; Danielson et al. 2010), the Southwest Alaska Network freshwater flow system monitoring protocol (Shearer and Moore 2011), monitoring protocols developed by the U.S. Geological Survey (USGS; notably Wagner et al. 2006), and instrument manuals from YSI Incorporated.

1.2 Hydrologic Setting

Water bodies in SEAN are diverse and numerous, including upland and subalpine lakes, wetlands and ponds, groundwaters, and glacial and non-glacial streams; each influenced by natural forces at multiple spatial scales such as geology, climate, and glaciers. GLBA, the largest unit in SEAN, has more than 310 streams (Soiseth and Milner 1995, NPS 2005) flowing over 3,380 km (2,100 mi). Two large, glacial, trans-boundary rivers flow through KLGO, and the lowest portion of one river is within the boundaries of SITK. The wet and moderate marine climate in the SEAN region is dominated by a strong Aleutian Low in the northern Gulf of Alaska in the fall, winter, and spring, and by weak high pressure systems in the summer. Low elevation areas are dominated by temperate rainforest while higher elevations in GLBA and KLGO have significant and rapidly changing glacial coverage. NPS Coastal Watershed Assessments (Eckert et al. 2006a, Eckert et al. 2006b, Hood et al. 2006) provide descriptions of the physical environment and condition of coastal resources in SEAN.

1.3 Purpose of Sampling

Freshwater water quality is an important indicator of the health of aquatic and terrestrial ecosystems across Southeast Alaska. This is reflected in SEAN conceptual ecological models, which illustrate the current understanding of important ecological processes within our parks (Moynahan et al. 2008). All SEAN units are concerned about the potential effects of climate change, human disturbance, and atmospheric contaminants on water quality. Other potential threats to water quality include urban development adjacent to watersheds within park boundaries and invasive or nuisance freshwater species. The freshwater water quality monitoring

program measures the core water quality indicators required for monitoring by all NPS networks (Irwin 2004): temperature, pH, dissolved oxygen (DO), and specific conductance (conductivity at 25°C). Additionally, because of the glacial influence on sediment transport, turbidity is measured in the Taiya River. Methodologies for measuring these core parameters are well developed and relatively affordable.

1.4 Rationale for Selecting this Resource to Monitor

SEAN selected to monitor the water quality of stream networks, instead of lakes, ponds, or muskegs, because they widely integrate physical and chemical attributes of the terrestrial landscape, provide habitat to a large variety of organisms, and discharge to marine waters. NPS scientists and managers will use long-term stream water quality monitoring to evaluate potential water quality changes due to natural and human stressors (potential impairment), check for continued compliance with state and federal aquatic health standards, and eventually analyze water quality conditions in relation to variation in streamflow, climate patterns, aquatic invasive species, and other vital signs.

Although some NPS vital signs are concerned with visitor impacts on park resources, these are likely to have minimal impacts on freshwater water quality in SEAN. Portions of both the Salmon and Indian rivers flow through human-inhabited areas, and stretches of all three monitoring streams are accessible at least partially by trail, but visitor activities are unlikely to be directly influencing basic stream chemistry. Indirect impacts may result from the introduction of invasive species, trampling of streamside vegetation, and bank erosion. The Salmon River may be impacted from household waste along its slightly developed section downstream of GLBA through the town of Gustavus, but the upper portion monitored under this vital sign experiences light visitor use. Along the Taiya River there is relatively high visitor use of the Chilkoot trail, but no urbanization. Composting toilets have been installed to help mitigate potential problems associated with groundwater contamination from human waste. Other human influences on the chemistry of the Taiya River are unlikely to be significant since most visitor use occurs during the summer months when flows are highest. In the Indian River in SITK, visitors are generally restricted to improved trails and a footbridge crossing the river, so their impacts on stream chemistry are likely minimal as well.

1.5 Measurable Objectives

A long-term freshwater water quality monitoring program in SEAN will fulfill the following objectives:

- Track the status and trends of each core water quality parameter.
- Describe the timing and magnitude of seasonal (open water period May through October) variation of each core water quality parameter.
- Evaluate whether state and/or federal water quality standards are met or exceeded.

1.6 The Value of Monitoring Each Parameter

1.6.1 Specific Conductance

Specific conductance, measured in mS/cm, measures the ability of the water to conduct an electrical current at 25°C. Conductivity is the same measurement but uncorrected for ambient water temperature. Specific conductance is easily measured and usually well correlated with the proportion of ionic components in dissolved solids. High specific conductance measurements typically represent strong groundwater influence, while low measurements may represent runoff events due to rain and snowmelt containing small amounts of dissolved ions. Currently, there are no State of Alaska standards for conductivity (ADEC 2012).

1.6.2 pH

pH is a unit-less measure of the acidity or alkalinity of a solution and is dependent on the activity of hydronium ions ($-\log_{10}$ of H_3O^+) in solution. Typical stream pH values range from 6.5 to 8.0. Changes in pH values can affect the dissolved concentrations of major ions, total organic carbon, and trace metals by influencing the partitioning between dissolved and solid phases. These concentrations may regulate biogeochemical processes, including sulfate reduction, N_2 fixation, and organic matter decomposition. Freshwater pH values typically display diel variation due to photosynthesis-respiration reactions and variations in the extent of ground and surface water interactions. The most stringent State of Alaska standards are for the growth and propagation of fish, shellfish, other aquatic life, and wildlife, which state that pH may not be less than 6.5, greater than 8.5, or vary more than 0.5 pH units from natural conditions (ADEC 2012).

1.6.3 Dissolved Oxygen (DO)

DO in a stream is typically regulated by water and air temperature, atmospheric pressure, hydraulic stream characteristics, photosynthetic or respiratory activity of stream biota, and the quantity of organic matter present (Hem 1985). Adequate DO is essential for the survival of most aquatic organisms, including salmon and other fish species indigenous to southeast Alaska. Alaska water quality standards state that DO must be greater than 7 mg/L in water used by anadromous or resident fish, and in no case may DO be less than 5 mg/L to a depth of 20 cm in the interstitial waters of gravel used by these fish (ADEC 2012).

1.6.4 Water Temperature

Water temperature plays an important role in physiological and biological processes of stream organisms, affecting fish metabolism, growth rates, and oxygen solubility. Alaska water quality standards state that temperature may not exceed 20°C at any time, 13°C for egg and fry incubation and spawning areas, and 15°C in migration routes and rearing areas (ADEC 2012). Water temperature trends often mirror air temperature trends, except in glacially-influenced streams, where warm air temperatures may trigger cold glacial melt episodes. Water temperature trends are often correlated with the timing and magnitude of streamflow. Both temperature and streamflow are directly influenced by climate change, which may alter the frequency of extreme weather events and the magnitude and timing of precipitation.

1.6.5 Turbidity

Turbidity is a measure of water clarity (Nephelometric Turbidity Units; NTU) and may be influenced by algal photosynthesis, primary productivity, or most important for the glacially-influenced Taiya River, suspended solid concentrations. Clearwater streams in southeast Alaska

typically measure <3 NTU, while glacially-influenced waters may demonstrate turbidity ranging from hundreds to thousands of NTU. Alaska turbidity standards vary based on designated uses, but the most stringent are related to water recreation, where turbidity may not increase more than 10% when natural conditions are greater than 50 NTU, not to exceed 15 NTU. Turbidity will be monitored only at the Taiya River due to the strong glacial influence on its hydrochemical characteristics and the concern that turbidity dynamics may be influenced by climate change.

1.7 Overview of Prior Water Quality Sampling

At this time of this publication, three years of continuous seasonal water quality data have been collected by SEAN. Previously, a limited number of brief studies within SEAN units have provided water quality monitoring data, and none have included long-term or continuous monitoring efforts (Eckert et al. 2006a, Eckert et al. 2006b, Hood et al. 2006, Nagorski and Hood 2007). These limited data illustrate that overall water quality conditions in SEAN are very high. The only stream designated as 303(d) impaired is Pullen Creek, a portion of which flows through the Skagway Historic Unit (in KLGO) but is not under NPS jurisdiction (ADEC 2010). A brief summary of water quality status and relevant references for the streams targeted for SEAN monitoring are provided below.

1.7.1 Glacier Bay National Park and Preserve

The most recent comprehensive reviews of GLBA water resources include the water quality synopsis report (Nagorski and Hood 2007) and the NPS Water Resources Division (WRD) coastal watershed assessment report (Eckert et al. 2006a). Earlier compilations include results of all water quality research from the 1960s to 1995 (NPS 1995) and studies relating to Falls Creek and the Falls Creek Hydroelectric Project (Gustavus Electric Company 2004). Rapid deglaciation in GLBA has stimulated numerous studies on the physical, chemical, and biological succession of watersheds following glacial retreat (e.g., Chapin et al. 1994, Engstrom et al. 2000, Milner et al. 2007).

The primary freshwater system for long-term monitoring in GLBA is the Salmon River, a 32.7 km long stream within an 11,552 ha watershed that hosts runs of steelhead trout (*Oncorhynchus mykiss*), cutthroat trout (*O. clarki clarki*), Dolly Varden (*Salvelinus malma*), and pink (*O. gorbuscha*), coho (*O. kisutch*), and chum (*O. keta*) salmon. The Salmon River's lowermost portion (river km 0.0 to 9.0) is outside of NPS boundaries and within the town of Gustavus. Before the SEAN program, existing water quality information for the Salmon River was limited to a cooperative USGS-NPS two-year field study on mercury contamination (also included Rink Creek and Good River) and several unpublished spot measurements taken at a tidally influenced site between January and July, 2006. SEAN has summarized water quality data collected seasonally in the Salmon River from 2010 through 2012 (Sergeant 2013).

1.7.2 Klondike Gold Rush National Historical Park

The most recent and comprehensive reviews of KLGO water resources are the Nagorski and Hood (2007) report to the NPS and the NPS-WRD coastal watershed assessment report (Hood et al. 2006). Earlier reviews include portions of the NPS Baseline Water Quality Data Analysis and Inventory (NPS 1998a), the Pullen Creek Action Plan (Taiya Inlet Watershed Council 2006), and Pullen Creek Total Maximum Daily Load Report (ADEC 2010). Additionally, a single sampling event of core water quality parameters, mercury, and persistent organic pollutants in water,

sediment, and tissues of benthic macroinvertebrates and juvenile salmon were collected from the Taiya and Skagway rivers in July 2007 (Nagorski et al. 2011).

The majority of previously available Taiya River data comes from a USGS stream discharge gaging station in the lower river at the bridge crossing where the Chilkoot Trail begins. Water quality data from this station includes color, DO, dissolved CO₂, acid neutralizing capacity, alkalinity, hardness, turbidity, suspended solids, nutrients, trace metals, major cations, and major anions, collected on 2 to 11 occasions per year by the USGS from 1969 to 1977. Temperature, specific conductance, and pH data are provided for 22 to 30 events per year during the same time period. Since the gaging station was restarted in 2004, in partnership with the NPS, measurements are available every 15 minutes for discharge, stage height, precipitation, and water temperature. Historical and current Taiya River gaging station data is available through the SEAN web site and directly from the USGS at:

http://waterdata.usgs.gov/nwis/uv?site_no=15056210. SEAN has summarized water quality data collected seasonally in the Taiya River from 2011 through 2012 (Sergeant 2013).

1.7.3 Sitka National Historical Park

The Indian River in SITK was included in the coastal watershed assessment report (Eckert et al. 2006b), NPS baseline water quality inventory (NPS 1998b), and 2007 water quality synopsis for NPS (Nagorski and Hood 2007). USGS recently assessed Indian River water quality (Neal et al. 2004) and has intermittently maintained one or two gaging stations since 1981. An environmental site assessment of the Indian River Asphalt Site (Shannon & Wilson, Inc. 1995) and subsequent monitoring (1996–2006) of water quality and soil from two stream locations adjacent to the site provide another source of information. Since 2007, other studies by SITK staff have included measurements of temperature, DO, pH, and specific conductance. A single sampling event of core water quality parameters, mercury, and persistent organic pollutants in water, sediment, and tissues of benthic macroinvertebrates and juvenile salmon were collected from the Indian River in June 2007 (Nagorski et al. 2011).

A USGS report (Neal et al. 2004) contains some of the most detailed past information on water quality on the Indian River. Two water sampling sites were measured every 6 to 8 weeks from January 2001 to September 2002 for pH, specific conductance, temperature, DO, alkalinity, cations, anions, nutrients, and total suspended solids. Physical habitat, algae, macroinvertebrates, and sediments were sampled during single events. Sediments were analyzed for heavy metals, arsenic, 65 organic compounds, and organic carbon. SEAN has summarized water quality data collected seasonally in the Indian River from 2010 through 2012 (Sergeant 2013). Water quality monitoring will continue to be important in the Indian River watershed as urbanization continues to spread upstream of park boundaries (more discussion in Section 7.3).

2. Sampling Design

2.1 Rationale for Site Selection and Sampling Design

The three freshwater water quality monitoring streams were chosen based on dependable site access and the ability to co-locate monitoring sites with related vital signs such as freshwater contaminants and streamflow. Site access is an important consideration in SEAN, and GLBA especially, where the lack of roads and trails, challenging terrain, and the typically cold and wet climate greatly restrict the ability to safely and successfully access most of the watersheds in the park. Therefore, the Technical Committee agreed that the use of randomly-based site selection could not be implemented for freshwater monitoring. While the single-site approach allows for high-resolution monitoring of specific watersheds for basic water quality parameters, the largest scale for inference is restricted to no more than a single watershed.

2.2 Site Selection within each SEAN Unit

The SEAN Technical Committee agreed that at least one stream from each of the three SEAN units should be represented in the freshwater monitoring efforts. Funding and staffing limitations have not allowed monitoring more than three streams in SEAN, even though GLBA covers a vastly greater surface area than SITK and KLGO, with hundreds of streams of various types and sizes. Only one freshwater body, the Indian River, is present at SITK, so no other option was available. The site location was driven by the presence of a stream gaging station near a bridge crossing at the northern boundary of the park (Figure 1).



Figure 1. Monitoring station on the Indian River in SITK (large red circle near NE corner of map).

Two rivers are present in KLGO, the Taiya and Skagway rivers. The Taiya River was chosen because it encompasses a larger area with heavier visitor use (especially along the Chilkoot Trail), has a maintained USGS gaging station within the park, and extends to the intertidal zone (Figure 2).



Figure 2. Monitoring station on the Taiya River in KLGO (large red circle near SW corner of map).

In GLBA, the choice was more difficult. After extensive discussion, SEAN staff decided that the Salmon River (Figure 3), rather than a randomly selected stream or the relatively well-studied Bartlett River, should be targeted for monitoring because it is:

- accessible by foot year-round from Gustavus roads
- large enough to encompass a variety of physical features (e.g., peatlands, forested uplands)
- habitat for Dolly Varden, coho, pink, and chum salmon, and cutthroat and steelhead trout
- representative of other similarly sized, coastal, non-glacial streams in GLBA
- part of a USGS/NPS water quality study ending in fall 2011 that includes bimonthly to monthly monitoring of the core parameters
- potentially a good candidate for future cooperative monitoring with the town of Gustavus

The Bartlett and Alsek rivers were strong candidates for long-term monitoring in GLBA. Although NPS scientists have invested several years of effort in fish surveys and core water quality and quantity profiles on the Bartlett River, the main logistical weakness is the river's lengthy trail access (over 4 miles from Headquarters to above tidally-influenced zone). Park staff

felt that it would be more difficult to commit to monthly site visits at the Bartlett than the Salmon River. The Alsek River was not selected for monitoring primarily because it is expensive and difficult to access, and its particularly large size (drainage area 2,000,000 ha) is anomalous even for GLBA. The Alsek River also has an established USGS gaging station that collects some basic water quality data.



Figure 3. Monitoring station on the Salmon River in GLBA (large red circle near SE corner of map).

2.3 Definition of the Sampling Boundaries

High-resolution water quality data collected at a single fixed location will generally capture the integrated water quality status and trends of the upstream reach and can potentially represent some portion downstream. The program's scope of inference can be altered by major changes in adjacent land use, forest type, physical/chemical modifications upstream, or changes to station location.

2.4 Sampling Frequency and Replication

Because changes in water quality can be rapid and short-lived, we employ a high-frequency sampling design to track seasonal variation in the status and trends of core water quality parameters. All of the core parameters can be monitored continuously using readily available instruments. Diel variations in values of the core parameters will be controlled largely by instream photosynthetic activity, outside air temperature, precipitation events, surface and groundwater interactions, transpiration by floodplain vegetation, and upstream gains or losses of source waters with varying physicochemical characteristics. While a 15-minute interval would

result in a highly detailed record that would be synchronized with the typical interval used by USGS gaging stations, this frequency would also require more intensive management and frequent battery changes, with little to no added value to the long-term dataset. Hourly measurements, the interval chosen for this monitoring effort, over the course of the ice-free portion of the year (May thru October) will provide a manageable yet highly informative dataset that would adequately satisfy the monitoring objectives. This seasonal timing will allow the instruments to function better in above-freezing temperatures, provide better site access, capture the majority of variation in stream physicochemical characteristics, and eliminate the risk of equipment damage to freezing or ice impact. Hourly measurements can be obtained using the same battery pack for approximately 75 days or longer, assuming fairly warm weather conditions (Randy Hadland, YSI Incorporated, personal communication, 2008), and ensure that the data set remains continuous if logistical issues result in a missed monthly site visit.

2.5 Trend and Variability Detection

Hourly measurements provide high resolution for short- and long-term changes in basic physicochemical stream characteristics. Even with occasional readings that do not pass quality assurance/quality control (QA/QC) criteria, hourly data for the core parameters from 6 months of each year provide a robust record for evaluating long-term status and trends. Stringent QA/QC criteria (SOP 2) dictate the margin of allowable error in the accuracy and precision of each instrument and validity of detected changes over time. The minimum level of detectable change in each core parameter is equal to the maximum level of allowable drift or error margin for each.

3. Overview of Field Methods

This chapter provides a general overview of field methods. Complete details are presented in SOPs 1 and 3.

The SEAN ecologist, as Project Leader, is responsible for the management, administration, and productivity of the water quality monitoring program. The Project Leader relies on park staff (Park Leads) for site visits and data collection. The Project Leader and Park Leads are supported by the SEAN Data Manager. Specific roles and responsibilities are detailed in Chapter 4 and the relevant SOPs.

3.1 Instrument Selection and Set-up

This program uses instruments manufactured by YSI Incorporated. As technology changes, monitoring instruments may be replaced or augmented with other models from YSI or other manufacturers. Specific instrument and field instructions are detailed in SOP 1.

SEAN currently uses the following instruments:

- 6920V2-2 Multi-parameter water quality logger, including
 - 6560 Conductivity/Temperature probe kit
 - RS-232 and SDI-12 communications interfaces
 - EcoWatch software
 - 2 optical ports; 1 pH/ORP port, 1 ISE
- 6561 pH field replaceable 6-series probe kit
- 6150 ROX optical oxygen sensor with titanium wiper shaft
- 6136 Turbidity probe
- 6091 25 Foot field cable
- 650 Multiparameter display system

3.2 Installation of Monitoring Stations

A properly installed monitoring station is secure, minimally visible to park visitors, operates under a variety of stream flows, and is safely accessible to personnel for calibration checks, battery replacements, and data downloading. A four-inch diameter perforated ABS pipe serves as the sonde mount (Figure 4). The pipe is either mounted to an immobile stream structure such as a boulder or attached to an angle-iron rod securely placed into the streambed. A bolt is inserted through the pipe where probe depth is targeted. The sonde is inserted into the installed pipe and rests on the bolt. The interface cable for the 650 MDS can be stored inside the pipe and made accessible from the top of the pipe, but this protocol directs that the download cable be connected during each data download event and not be stored in the pipe. When the sonde is not being serviced the mounting pipe will be capped to provide some protection against vandalism and sediment build-up.



Figure 4. Example of sonde pipe installation from the Indian River. The black ABS pipe is anchored to the boulder in the left side of the photo. The pipe cap is not shown.

3.3 Field Season Preparations

Each winter, the Project Leader receives the instruments from the Park Leads and sends them to the manufacturer for cleaning, recalibration, and performance checks. Although pH, DO, specific conductance, and turbidity can be recalibrated fairly easily by NPS personnel, temperature and barometric pressure are difficult to verify with high accuracy and are evaluated by the manufacturer. After field deployment, instrument probes and components may accumulate sediment and/or biofouling in screw threads and other crevices. We typically rely on the manufacturer to loosen, clean, and replace these sensitive areas as needed, because improper handling during cleaning or repair by NPS personnel may void instrument warranties.

Park Leads, with the support of the Project Leader, are responsible for maintaining adequate supplies of data sheets, calibration standards, extra batteries, field notebooks, pens and pencils, and hard copies of the protocol and pertinent SOPs. The SEAN Project Leader ensures that adequate supplies are delivered promptly as needed.

Each year, the Project Leader trains Park Leads on instrument calibration, use, and maintenance. Due to the potential for losing up to a month of data between site visits, it is extremely important that staff collecting water quality data closely follow these protocols and receive proper training before each season. A pre-season inspection of the monitoring stations confirms that no components were damaged or lost during the winter season. On the Indian and Taiya rivers, bolts on support structures are checked. On the Salmon River, the stabilizing angle-iron rod is

reinstalled. The initial inspection at SITK and KLGO are conducted at least one month (approximately April 1) in advance of instrument deployment to allow for potential repairs.

3.4 Field Operations

Under normal conditions, sondes will be installed and logging before May 1 each year. Each monitoring station is visited on a monthly basis by designated park staff to conduct data downloads and instrument maintenance and calibration. Downloading data on the last day or first day of each month is preferable, but a five-day calendar day window for the monthly site visit is acceptable. SOPs 1 and 3 provide detailed procedures for each visit, including calibration checks and data downloads.

In cases of extreme weather and high-flow conditions, the monitoring instruments will be temporarily pulled out of operation if there is substantial risk of damage or loss. In such cases, staff should make their best effort to track daily conditions and reinstall sondes as soon as conditions safely allow. If removed, the sonde is properly stored according to the procedures described in Section 10.0 of SOP 1. Installation or removal should never occur under conditions that endanger park personnel.

3.5 Data Transmission

Following each monthly site visit, Park Leads transmit data to the Project Leader using the procedures in SOP 3, which includes information on depositing downloaded data, transferring and storing field data sheets, and contacting the Project Leader with questions or any repairs.

Park Leads transmit raw data and field sheets monthly to the Project Leader in the format outlined in SOP 3. The Project Leader ensures the accurate transmission of data, stores the data within the specified file structure, and officially acknowledges receipt of the data from the Park Lead. These data are stored until end-of-season processing and reporting.

3.6 End-of-Season Procedures

At the end of every deployment season (around October 31), the sondes are retrieved, undergo a local error check, appropriately stored, packaged, then shipped to the Project Leader. The Project Leader inventories equipment before sending to the manufacturer for annual cleaning, calibrations, and repairs. These procedures are described in detail in Section 12 of SOP 1.

4. Data Handling, Analysis, and Reporting

This chapter describes the general approaches to generating, maintaining, and disseminating the data products created under this monitoring protocol. Detailed procedures are provided in product-specific SOPs. Detailed product definitions are in Appendix D.

4.1 Overview of Information Architecture

Data in the freshwater water quality monitoring program are managed according to the standard methods used by all SEAN programs, as described in the SEAN Data Management Plan (Johnson and Moynahan 2008). The model from which these methods were derived is illustrated in Figure 5.

Dissemination of all program data is done electronically from SEAN and partner web sites, including the NPS Integrated Resource Management Applications (IRMA). Certain reports are also published by NPS as natural resource reports, natural resource technical reports, or natural resource data series products.

4.2 Overview of Data Products

The freshwater water quality program creates and maintains ten specific data products, also referred to in this document as deliverables. SEAN deliverables:

- come from a single authoritative source
- contain content that is comprehensively documented in a referenced protocol
- are discoverable and deliverable to the all users on the web
- are always certified to be at a level of quality defined in the parent protocol
- are permanently backed up and are also archived to appropriate third parties, when such parties exist

Each deliverable is disseminated from SEAN and, for some items, partner web sites. The SEAN web site is the single authoritative source for these deliverables. In the event that a data product distributed by a partner diverges from the values disseminated by SEAN, the SEAN version should be used.

The deliverables are provided in a variety of file formats and frequencies and each has a single, detailed SOP to use in building it (summarized in Table 1 and fully defined in Appendix D). Accompanying each deliverable definition in Appendix D is a data flow diagram illustrating the deliverable's source, processes that are applied, storage location, and a responsible individual (Figures APP D.1–D.10).

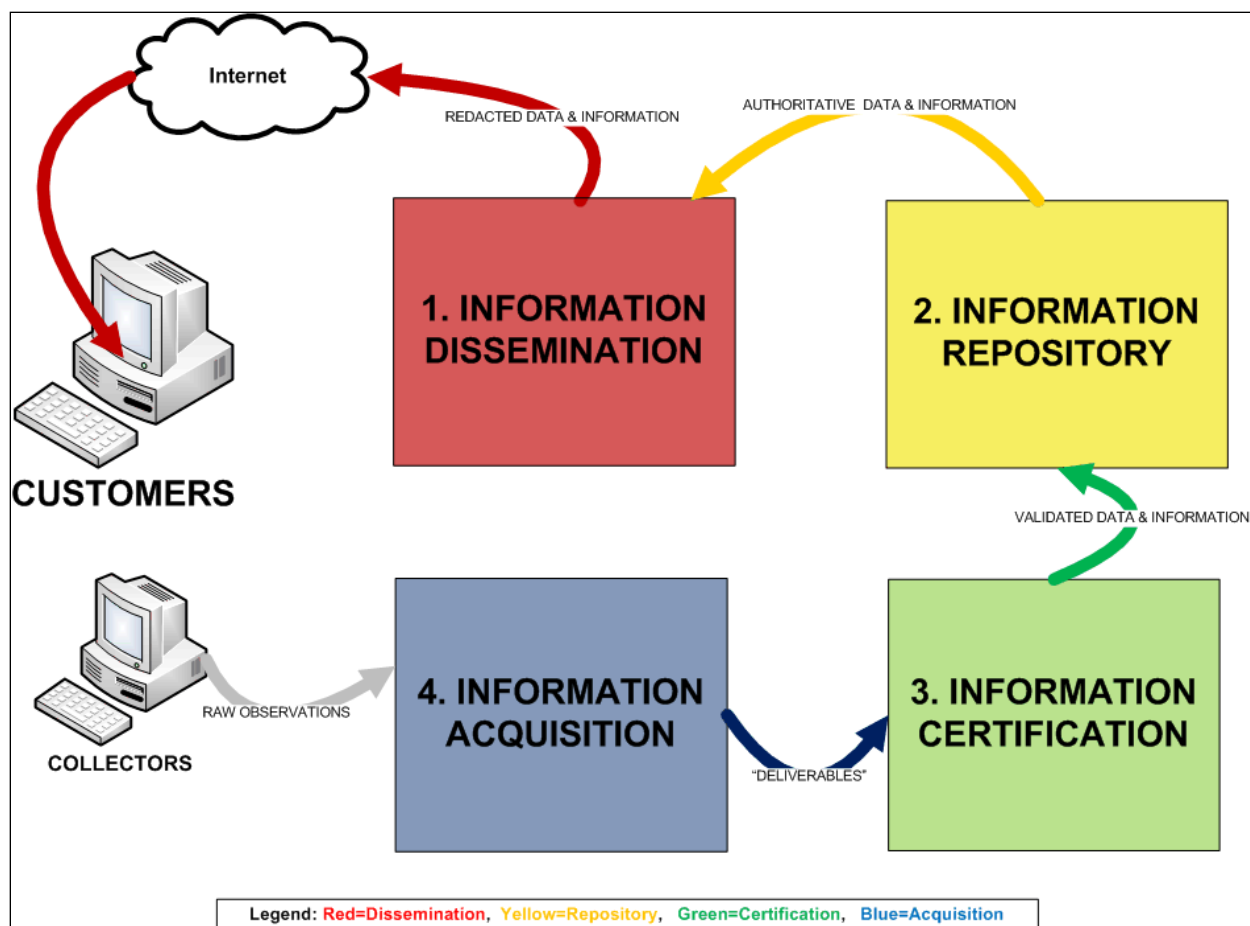


Figure 5. The SEAN Core Functional Model overview. Dissemination services (red) provide all deliverables to all customers using Internet web servers. Repositories (yellow) store the certified inventory and monitoring products called for in the protocols. Certification processes (green) assure repositories have the highest quality data and that sensitive items are restricted to authorized users. Data acquisition processes (blue) led by park staff and cooperators include a wide array of tasks, ranging from collecting raw data to producing reports on long-term trends.

Table 1. The SEAN data deliverables provided by the freshwater water quality monitoring program.

Deliverable Title	Description	Provided to Customers as	Frequency Produced	Responsibility	SOP
FQ_A: Protocol	Detailed document defining the freshwater water quality monitoring program; each revision exhibiting a unique protocol ID.	One PDF file.	As needed, prior to the field season for which it becomes effective.	Program Manager	4
FQ_B: Data availability	Data availability matrix documenting which data are available in the FQ_F database.	One cumulative PDF file covering all years and sites.	Typically once per calendar year following certification of the latest FQ_F.	Data Manager	5
FQ_C: Site visit worksheet	One worksheet per site visit documenting actions taken (e.g., sensor cleaning and recalibration), calibration values, and data quality levels used for later data flagging.	Windows files in MS XLSX format, wrapped into a single ZIP file.	One ZIP file per calendar year containing all visits to all sites.	Project Leader	6
FQ_D: Maintenance log images	Images of sonde maintenance records.	One PDF file for each instrument covering a full calendar year.	Once following return of sondes from service vendor.	Project Leader	7
FQ_E: Sonde raw data	The cumulative season's collection of raw sonde output in proprietary YSI RC-6000 ".DAT" format. It is extracted during each visit to each site, and then again after the sonde is pulled from service for the season. No alterations or corrections are applied to this product.	Windows data files of sonde output in proprietary ".DAT" format wrapped into a single ZIP file.	One ZIP file per calendar year containing all sites.	Project Leader	8
FQ_F: Database	A single cumulative database reflecting all certified FQ_J sonde data.	ASCII CSV extract files downloaded from the SEAN's webserver and saved onto local workstations	Continuously available; updates typically made once per year.	Data Manager	9
FQ_G: Annual report	Annual report summarizing operations and data.	One PDF file.	Once per year after certification of the corresponding FQ_F data.	Project Leader	10
FQ_H: Five-year report	Five-year analysis reviewing trends and regional comparisons in the collected parameters.	One PDF file.	Once every fifth year following completion of the latest FQ_G annual report.	Project Leader	11
FQ_I: NPStoret submission	Data comprising FQ_F are delivered by SEAN to NPS Water Resources Division (WRD) for incorporation into their NPStoret database. WRD subsequently forwards it to EPA for incorporation into the STORET national water quality database.	One cumulative ASCII CSV file covering data for all years and one ASCII CSV file containing summary statistics for each parameter measured.	Once per year after certification of the underlying FQ_F data.	Data Manager	12
FQ_J: CSV data	The cumulative season's collection of sonde output in ASCII CSV format having duplicate readings removed, data adjustments applied, and quality flags assigned.	One Windows ASCII CSV data file for each sonde, packaged into a single ZIP file.	Once per year, following certification of underlying FQ_E data.	Project Leader	13

4.3 Overview of Formal Analyses and Reports

Freshwater water quality data will not only be disseminated from the SEAN web site, but also summarized in annual (SOP 10) and five-year (SOP 11) reports produced by the Project Leader.

Annual reports summarize results of a single continuous sampling season for all three parks (GLBA, KLGO, and SITK) and are completed by the Project Leader by the end of the same calendar year. The annual report provides summary figures and tables for the status and trends of core water quality parameters, offers short- and long-term trend interpretation, and discusses future monitoring program considerations. Figures will include line graphs of time series data for each water quality parameter, box plots summarizing the range of values for each parameter, tables of monthly values, and a period of record summarizing all measurements recorded in SEAN's water quality monitoring program.

Five-year synthesis reports will begin in 2016 and every five years thereafter. In these reports, the Project Leader will conduct a more detailed analysis of long-term status and trends in SEAN freshwater water quality data. Additional regional datasets and any available streamflow data may be integrated with SEAN freshwater water quality monitoring to form comparisons over broader temporal and spatial scales. Greater detail for each of these reports is found in SOPs 10 and 11.

4.4 Dissemination: Accessing the Data Deliverables

In keeping with SEAN's data management policies, customers access all of the freshwater water quality program's deliverables directly from SEAN's public web site (Figure 6). The web site also contains useful ancillary information and references to relevant published and gray literature. Most example links in Figure 6 are top-level and refer to subordinate areas that offer customers the ability to select information covering specific years or filtered by specific parameters. Pages also provide access to formal FGDC metadata in XML format for each specific deliverable type, where appropriate. Figure 6 is intended to illustrate content only. The actual layout, graphics, and enterprise links used will follow the guidance of the national Inventory and Monitoring program. While the dissemination services are publicly available worldwide, the target audiences are NPS managers and resource specialists, and the broader scientific community.

Copies of certified sonde data are distributed to NPS WRD for incorporation into the NPStoret system. WRD is responsible for forwarding the SEAN data to the Environmental Protection Agency's national STORET water quality database (<http://www.epa.gov/storet/>). SEAN does not control program data once WRD assimilates it into their operations. Should discrepancies be found between WRD and SEAN data, SEAN is the authoritative source. WRD operations are documented at <http://www.nature.nps.gov/water/>.

Selected certified deliverables and their metadata are also installed in NPS's IRMA Data Store for further dissemination (<http://irma.nps.gov/>). Should discrepancies be found between copies of deliverables in IRMA and original SEAN web site products, SEAN is the authoritative source.

In the SEAN model (Figure 5), the Project Leader is also a customer. When creating a product based on earlier deliverables (e.g., annual or five-year reports), the Project Leader uses as source material the certified SEAN deliverables from the web; the Project Leader's local work files are

not used. This process assures that deliverable creation processes only use authoritative data and, thereby, are reproducible.

No deliverables of the freshwater quality monitoring program are currently considered sensitive. Should a future policy revision classify some as sensitive, they will be sequestered at SEAN and will not be available for general dissemination. Questions regarding existence of sequestered products should be directed to the Data Manager through the “Contact Information” link of the web site.

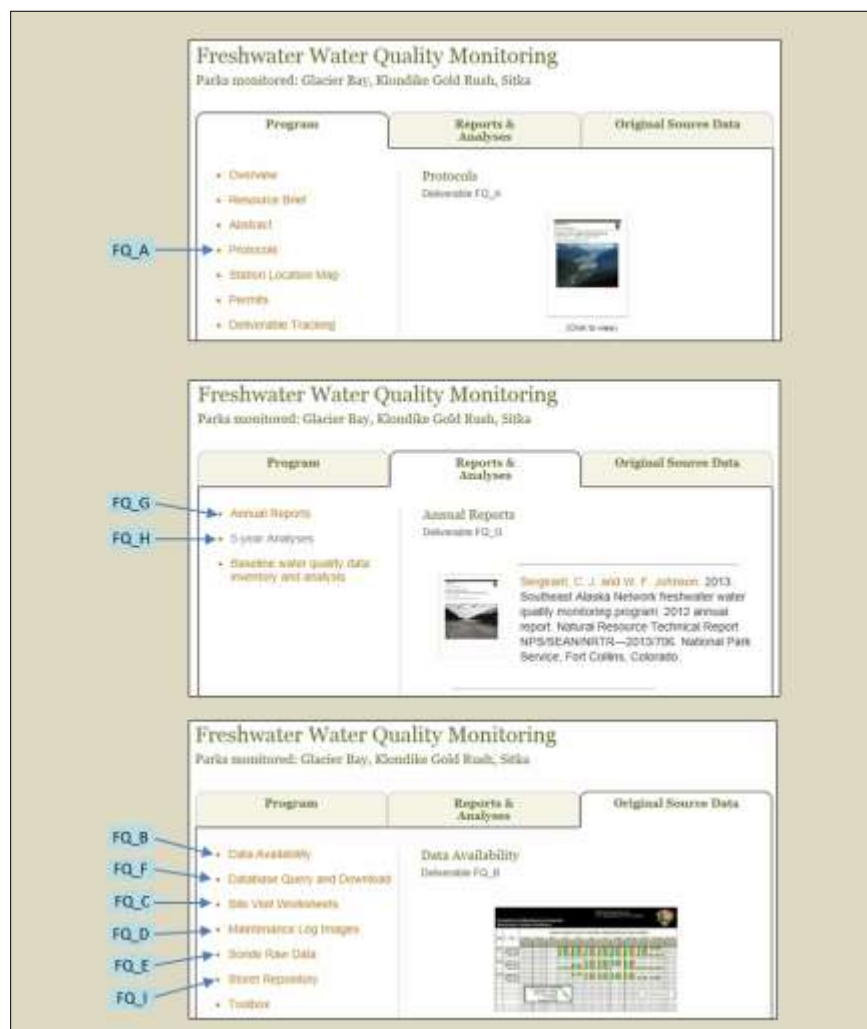


Figure 6. Freshwater water quality monitoring program deliverable products identified on the three tabs of the program's main dissemination web page.

4.5 Repository: Data Archiving

Freshwater water quality program data are maintained in SEAN's Auxiliary Repository and Database on equipment located in the SEAN office in Juneau, Alaska. Parts of the SEAN Data Management Plan detail the comprehensive Juneau backup and restore mechanism (Johnson and Moynahan 2008: SOP 204 – Backup and Restore Routines, SOP 1101 - Network Archiving Process). Chapter 11 of the Data Management Plan covers the philosophy of records management at SEAN.

Content of the Auxiliary Repository is also mirrored at the production web site and database facilities of the NPS Natural Resource Stewardship and Science Directorate (NRSS) in Colorado, from which it is disseminated to the public. The NRSS uses enterprise-level business continuity processes to maintain their mirror of SEAN's repository.

Original copies of submissions to outside repositories (*e.g.*, FQ_I for NPS Water Resources Division) are version-tracked and retained in the staging area of SEAN's Juneau network. Doing this permits reconstruction of failed external repositories. Similarly, WRD archives permit reconstruction of parts of SEAN databases in the event of disaster.

4.6 Deliverable Validation and Certification

The three Park Leads collect their data components monthly and forward those to the Project Leader using the processes specified in SOP 3. The Project Leader verifies that the components arrived complete. If something required is missing, the component is returned to the park for correction and resubmission. Complete items are accumulated by the Project Leader in a work zone on a robust network file server at SEAN.

After the season ends and all components have been received by the Project Leader, that person assembles and formats formal deliverables according to the processes specified in the respective SOP for each deliverable.

Each deliverable goes through rigorous validation processes to ensure it meets mandatory quality control criteria. After a submitted product meets all mandatory criteria, the originator reviews the final version and, if completely satisfied, certifies it. Once certified, the Data Manager installs it in the repository and ensures it is properly accessible from the dissemination web site. The SEAN Data Management Plan describes the approach to validation and certification (Johnson and Moynahan 2008: Section 6.4 and SOP 601 – Procedures for Certifying Project Data).

Appendix D of this protocol explicitly defines the set of mandatory and optional validation criteria enforced over every deliverable in the freshwater quality monitoring program.

Certification requires orchestrating a set of tasks between the Project Leader and Data Manager (generically depicted in Figure 7). For each deliverable, these tasks are detailed in their respective SOP. Specific interactions between Project Leader and Data Manager are graphically illustrated for each deliverable in the data flow diagrams in Appendix D.

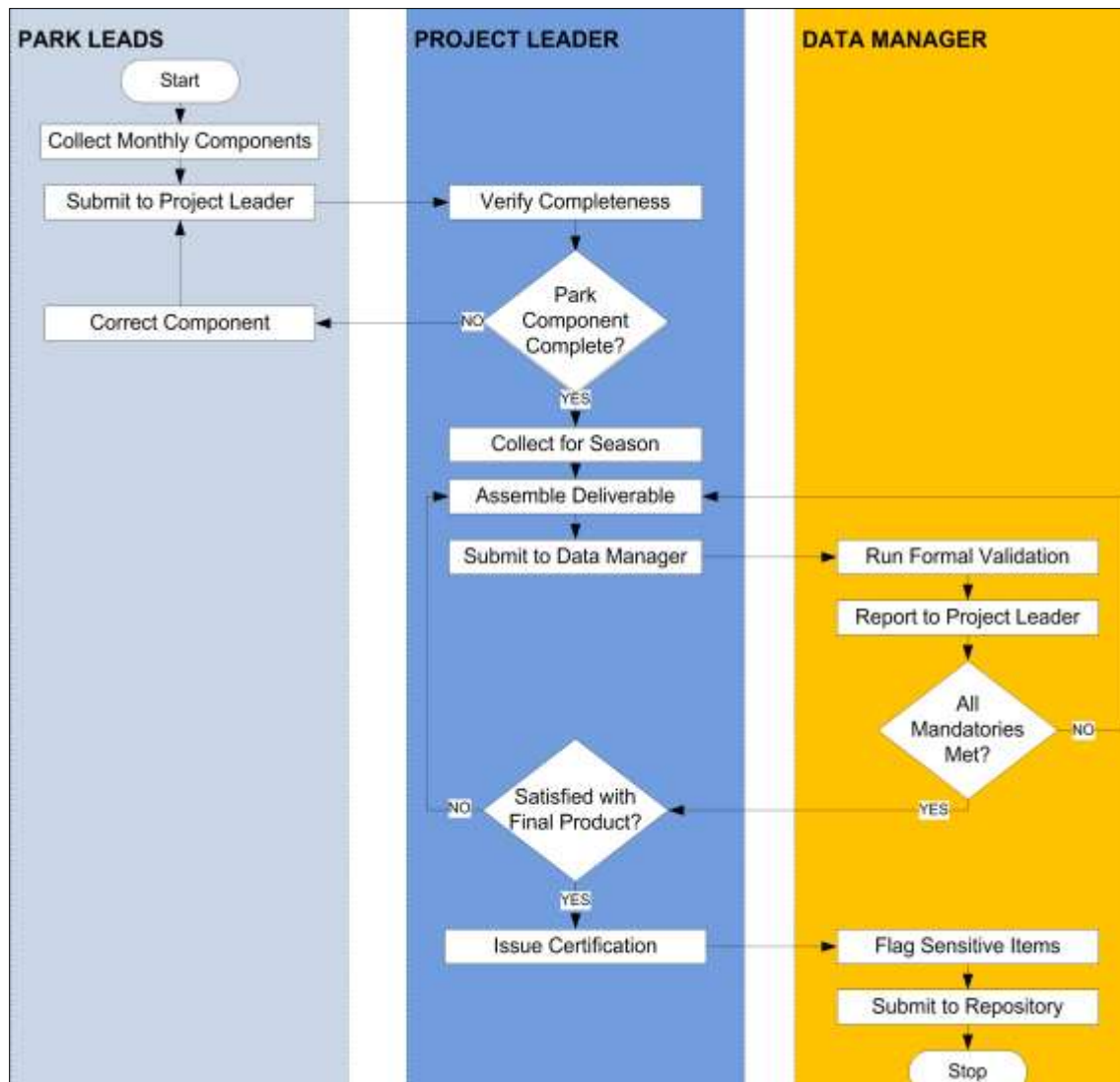


Figure 7. Sequence of tasks and staff responsibilities used in the SEAN certification process.

4.7 Data Acquisition: Scheduling Deliverable Creation

A set of prerequisites must be completed before most deliverables can be generated. That is, creating some deliverables may be dependent on prior certification of other deliverables, which, in turn, may have their own dependencies. Figure 8 illustrates the typical order used in creating the products. Besides formal deliverables, key intermediate processes are also noted in the proper sequence. Due to the numerous circumstances and exceptions one may encounter while operating the monitoring program, it may be necessary to revise the order of execution *ad hoc*. Figure 8 is only an example; the Project Leader may identify acceptable variations.

PRE-SEASON

In SEAN Office

Send sondes out for annual maintenance/calibration

Collect maintenance reports for FQ_D product

IN-SEASON

Each Site

Each Month May - October

In the field

Dump sonde to handheld capture device ("650")

Visually verify file contents appear complete

Fill in a new site visit worksheet paper form that documents the calibration process and site observations

In the park office

Enter site visit worksheet XLSX into network based on field paper form – verify accuracy of transcription (FQ_C component)

Dump handheld data file to NPS network location as a YSI PC6000 format ".dat" file – verify transfer is complete (FQ_E component)

Transmit the two files to the Project Leader

POST-SEASON

Deliverable	Comment
FQ_C: site visit worksheets	One ZIP of all XLSX worksheets for whole year
FQ_D: sonde maintenance records	One PDF for each device/year assembled by Project Leader
FQ_E: sonde raw data files	One ZIP for whole season
FQ_J: CSV data files	One ZIP for whole season
FQ_F: cumulative database updates	Generated from certified FQ_J by Data Manager
FQ_G: annual report	Generated by Project Leader once FQ_F is certified
FQ_B: data availability matrix	Generated by Data Manager once FQ_F is certified
FQ_I: NPStoret WRD submission	Generated from certified FQ_F by Data Manager
FQ_H: Five-year report	Generated every fifth year from FQ_F and other sources
FQ_A: revised protocol	No fixed schedule; best implemented at start of season

Figure 8. Typical sequence of deliverable production.

4.8 Managing the Production Environment

For internet users to have access to I&M products, the content is required to be housed on what are called “production” file servers, database servers, and web servers. Publicly accessible production is currently physically housed in Colorado. Only fully-vetted, permanent items are allowed in the production environment. SEAN maintains its own environments in order to prepare content for production. These are referred to as the Development and Integration environments. They reside on their own servers located at the SEAN offices.

The technical details to observe in preparing the program’s data deliverables and installing them in production are addressed in SOP 14.

4.9 Metadata Maintenance

The Data Manager is responsible for maintaining FGDC-compliant metadata for each tabular deliverable. SEAN stores metadata as XML files and serves them on the SEAN webpage, alongside the deliverables they describe. SEAN uses NPS Metadata Editor and the NPS_Basic_Edit stylesheet for basic entry. Where data fields exist, SEAN extends the basic metadata by providing the Entity_and_Attribute_Information section. Metadata considerations are further addressed in Chapter 8 of the SEAN Data Management Plan (Johnson and Moynahan 2008).

5. Personnel Requirements and Training

5.1 Roles and Responsibilities

Installation, maintenance, and end-of-season decommissioning of monitoring stations, are performed by the Park Leads, overseen by the Project Leader, and detailed in SOP 1. Data downloads from the sondes are conducted by the Park Leads, who then forward those data to the Project Leader (SOP 3). The Project Leader and Data Manager are individually responsible for creating specific data products that are the outcome of this monitoring program (SOPs 5 through 12). The Data Manager and the Project Leader are jointly responsible for the data validation processes associated with those products. The resulting certified deliverables are installed in the NPS repository archive, linked on the appropriate SEAN webpage, and transmitted to external facilities by the Data Manager as specified in each product's SOP.

5.1.1 Project Leader (*Christopher Sergeant, SEAN*)

- Ensure completion of monitoring preparations prior to the field season, including
 - coordinate annual sonde maintenance;
 - confirm sondes, power, memory and display/logging configurations are ready pre-season;
 - order and stock calibration standards, batteries, log sheets, and other field items;
 - ensure that Park Leads are adequately trained;
 - ensure that monitoring stations are in good structural condition
- Train new Park Leads and other technicians in water quality monitoring
- Schedule and execute a safe and successful deployment of water quality sondes at the monitoring stations with Park Leads
- Track monthly station checks and data downloads by Park Leads
- Coordinate needed repairs and troubleshoot technical problems
- Declare monitoring stoppages due to weather or river conditions for the safety of personnel and equipment (this does not preclude Park Leads and technicians making independent decisions based on real-time conditions at the time of data downloading or station checks)
- Assemble and submit the data deliverables specified in Table 1 and defined in Appendix D to the Data Manager
- Correct deliverables as needed to meet mandatory validation criteria
- Formally certify deliverables that pass mandatory validation
- Assemble metadata entries that document exceptions and notable observations recorded in field notes
- Recommend to Program Manager when to initiate the protocol revision process (FQ_A)

5.1.2 Park Leads (*currently Craig Murdoch, GLBA; Jessica Wilbarger, KLGO; and Biologist, SITK*)

- Ensure completion of monitoring preparations prior to the field season, in coordination with the Project Leader, including:
 - Return sondes to Project Leader at the end of the monitoring season;
 - track supplies of calibration standards, batteries, log sheets, and other field items;
 - ensure proper storage of monitoring equipment when not deployed;
 - undergo protocol training with the Project Leader, when needed;

- identify monitoring or logistical issues to Project Leader
- At KLGO and SITK, visit the site on or around April 1 to check on overwinter condition of the sonde housing and hardware; work with Project Leader to complete any repairs prior to May 1
- Deploy sonde at the beginning of the monitoring season (before May 1)
- Complete sonde field log at each monthly station visit and immediately communicate issues with the Project Leader (e.g., unstable structures or inoperable probes)
- Perform monthly calibration checks, recalibrations, and data downloads
- Properly transfer the monthly downloaded data from the sonde to the Project Leader monthly during the season
- Recommend protocol improvements to the Project Leader

5.1.3 Data Manager (William Johnson, SEAN)

- Validate quality of deliverables against formal criteria
- Build facilities to disseminate products over the web
- Assemble, maintain, and disseminate metadata
- Track program progress and adherence to schedules
- Archive data and metadata as appropriate to the:
 - SEAN internal repository
 - NPS IRMA Data Store repository
 - NPS Water Resources Division NPStoret database
- Coordinate corrections so that deliverables posted to external archives continue to represent the best consistent project data
- Recommend improvements to the protocol to Program Manager

5.1.4 SEAN Program Manager

- Oversee program
- Review and approve annual and five-year reports
- Supervise Project Leader and Data Manager
- Coordinate with each park's Chief of Resources to secure commitments for Park Leads' time and responsibilities
- Oversee, coordinate, and approve protocol revisions

5.2 Qualifications

5.2.1 Project Leader

- Knowledge of:
 - General aquatic field survey logistics, protocols, and safety
 - Water quality monitoring instruments, data collection, and deployments
 - Downloading, evaluating, and processing water quality data
- Demonstrates an ability to:
 - Recognize and correct errors detected in data deliverables
 - Compile and analyze monitoring data for annual and five-year reports
 - Manage projects

5.2.2 Park Leads

- Knowledge of:
 - General aquatic field survey logistics, protocols, and safety
 - Water quality monitoring instruments, data collection, and deployments
- Demonstrates an ability to:
 - Check and calibrate sondes
 - Download data from the sonde to a computer to send Project Leader and Data Manager

5.2.3 Data Manager

- Expertise in:
 - Database management
 - Web programming
 - Data processing, validation, reporting, and archiving
 - Metadata management
 - Project management

5.3 Training Requirements

5.3.1 Project Leader

- Field station and sonde operation and maintenance
- Monthly Park Lead-transmitted data quality checks
- Record-keeping procedures
- Data processing and reporting

5.3.2 Park Leads

- Field station and sonde operation and maintenance
- Sonde calibration techniques
- Field log record-keeping procedures
- Data downloading and transmission

5.3.3 Data Manager

- Technical database management
- Technical web development
- Sonde data processing software capabilities and operations

6. Operational Requirements

6.1 Annual Workload and Field Schedule

The field season is May 1 through October 31. In the winter, sondes are sent back to the manufacturer for recalibration, routine maintenance, and any needed repairs. After returning from the manufacturer, the Project Leader ensures that all sondes are operating properly and ready for deployment. Sondes must be deployed and logging data before May 1.

Installation and decommissioning of the sondes into the continuous monitoring stations are expected to take one field day each, assuming stations have been checked and repaired, if needed, in the weeks prior to installation. Once the sondes are operational, about one half day of work is required to access the monitoring site, visually check station integrity, download the data, and check the calibration. More time may be needed for on-site minor repairs or recalibration.

We strongly recommend that more than one person in each park be able to perform the monthly monitoring activities. Redundancy reduces the burden on one individual and ensures operational continuity in the instance of schedule conflict, absence, or turnover. While the Project Leader can assume the full duties of the Park Lead, travel expenses for the Project Leader coming from Juneau are high and may not be affordable within the SEAN budget.

Project Leader duties will require approximately 18 days per year:

- 2 days coordinating annual sonde maintenance and supply orders
- 6 days per year visiting each park to check on station integrity and host training sessions
- 3 days resolving technical difficulties at the stations
- 1 day planning the sampling logistics
- 1 day conducting data verification with the Data Manager
- 1 day per year documenting and reviewing field log entries and notable observation in field notes
- 4 days producing the annual report

Approximately 15 days are required for five-year report preparation. More days may be required to finalize scope and specific objectives of the report.

Park Lead duties will require approximately 7 days per year:

- 2 days pre-deployment tasks (as listed in section 5.1.2)
- 3.5 days (approximately four hours on seven field days) for data download, station maintenance, and calibration
- 0.5 days communicating data and station condition updates to the Project Leader and Data Manager
- 2 days for general station maintenance and repair in addition to above duties, and for storing and shipping the sonde to the Project Leader at the end of the season

In some years, an additional 1–3 days may be required to check and service sites during adverse weather or river conditions.

Data Manager duties will require approximately 5 days per year.

6.2 Facility and Equipment Needs

At each park unit:

- Water quality monitoring station (infrastructure established in 2010 and varies by park)
- Water quality sonde
- Data download device and download cables
- Calibration solutions for turbidity (KLGO only), pH, and conductivity; and a NIST-traceable thermometer
- Deionized or distilled water
- Field notebooks and log forms
- Hard copy of protocol and field SOPs
- Phone
- Covered storage area for sondes, calibration solutions, cables, miscellaneous hardware, and spares
- Desktop computer with a serial port for retrieving data from MD-650
- YSI's proprietary cable to connect 650 to PC serial port
- Access to an NPS-networked file server for reliably storing data downloaded from MD-650

At the SEAN Juneau location:

- Backup sonde and sonde components, calibration standards, and other backup accessories
- NPS-networked IT infrastructure
- YSI 6095b cable for direct connection of sonde to PC serial port

6.3 Start-up Costs and Budget Considerations

Start-up costs for the monitoring program were far greater than normal annual monitoring costs. The three water quality sonde packages for the parks were purchased for approximately \$30,000. Additionally, two backup sondes with probes have been purchased for approximately \$15,000. Miscellaneous costs associated with building the infrastructure for the water quality monitoring stations in spring 2010 were estimated at about \$1,500, not including labor and travel costs to cover personnel contracted to conduct the work. Application development to automate the data processes r about 0.1 person-years of data manager resources; approximately \$10,500. All of these durable equipment and implementation costs were paid for by SEAN in FY09 through FY11 funds.

Total annual equipment and supply costs as of 2011 are approximately \$6,750 (Table 2). Annual servicing and calibration costs by the manufacturer will cost about \$800 per sonde per year, plus approximately \$200 per anti-fouling wiper kit for the optical probes, if needed.

Table 2. Estimated annual equipment and supply costs for the freshwater water quality monitoring program (updated March 2013).

Category	Item	Unit Quantity	Price per Unit	Units	Total	Comments
Calibration Standards	pH 4	4 L	\$ 42.00	3	\$ 126.00	
	pH 7	4 L	\$ 42.00	3	\$ 126.00	
	pH 10	4 L	\$ 42.00	3	\$ 126.00	
	1,000 µs/cm	8 pints	\$ 120.00	3	\$ 360.00	
	126 NTU	1 gall	\$ 322.90	1	\$ 322.90	
Sensors	Cond/Temp	1 sensor	\$ 530.00	1.5	\$ 795.00	For all probes, assume a life of two years
	DO	1 sensor	\$ 890.00	1.5	\$ 1,335.00	
	pH	1 sensor	\$ 250.00	1.5	\$ 375.00	
	Turbidity	1 sensor	\$1,530.00	0.5	\$ 765.00	New sensor every two years (KLGO)
Field Supplies	500 mL squirt bottles	1 sensor	\$ 15.00	6	\$ 90.00	Replace 2 per year
	Distilled water	1 gal	\$ 2.00	9	\$ 18.00	3 per park
	Rite in the Rain paper	25 sheets	\$ 30.00	3	\$ 90.00	1 box per park
	AA batteries	20 batteries	\$ 17.00	4	\$ 68.00	24 batteries per park, per year
	C batteries	12 batteries	\$ 15.00	1	\$ 15.00	4 per park per year
	Disposable wipes	1 box	\$ 7.00	3	\$ 21.00	
	YSI maintenance kit	1 kit	\$ 50.00	3	\$ 150.00	One per year per park
	Scrub brushes	1 brush	\$ 5.00	3	\$ 15.00	One per year per park
Shipping Costs			\$ 15.00	6	\$ 90.00	Assume \$15 per package; send 6 per year
20% Contingency					\$ 977.58	
Annual Total*					\$ 5,865.48	

* Assume 3% annual inflation increase

Depending on the expertise in-house at SEAN, the five-year report may benefit from contracting an external hydrologist or geochemist to help in the analysis, presentation, and interpretation of the collected dataset.

6.4 Protocol Revision Process

This protocol may be updated or revised as new knowledge, technologies, equipment, and methods become available. Revisions will balance the advantages of new techniques with possible disadvantages associated with disrupting data continuity.

All revisions require review for clarity and technical soundness. Small changes to the existing protocol documents—for example formatting, simple clarifications of existing content, small changes in the task schedule or project budget, or general updates to information management handling SOPs—may be reviewed in-house by project cooperators and SEAN staff. Changes to data collection, analysis techniques, or sampling design will trigger an external peer review to be coordinated by the Alaska Region Inventory and Monitoring Coordinator.

The SEAN Program Manager will periodically poll the Project Leader and Data Manager on the need to initiate a protocol revision cycle. Every effort will be made to ensure that complete, certified protocol revisions are applied at the start of a new continuous monitoring period (i.e., in early May). Exceptions include revisions that would remedy an identified safety deficiency or a significant issue of data quality or continuity of operations. The protocol document is defined as data deliverable FQ_A. The detailed process for revising it is in SOP 4.

7. Other Considerations

This monitoring program has been designed to document basic water quality status and trends in selected SEAN streams. By tracking seasonal and annual variations in core water quality parameters at a fine temporal scale, meaningful comparisons with current and future vital signs monitoring programs (e.g., streamflow and freshwater contaminants) located at or near the current water quality stations can be established.

7.1 Expansion of the Existing Program

The monitoring program can continue to grow with greater future staffing, scope, and budget. The first priority for additional funding would be increasing spatial coverage and establish identical core parameter monitoring stations at other streams, especially in GLBA where there is high diversity of stream age, size, and type. Monitoring glacially-influenced streams in GLBA should be a priority considering the rapidly changing influence of glacial meltwaters on watersheds. Some USGS water quality data exists on the Alsek River, but a smaller glacial stream in upper Glacier Bay would be the best candidate for an NPS-led monitoring station, while still posing considerable logistical challenges. Generally, linking the status and trends of water quality parameters to co-located streamflow gages would be very informative. In KLGO, the Skagway River could be included for future monitoring. The current Taiya River station may need to be modified or temporarily decommissioned in the event that the existing bridge is replaced.

In SITK, there are no other stream options for sampling, but the current site on the Indian River, just outside of the NPS boundaries, could experience vandalism or other issues because of its close proximity to a population center. If issues arise, the park footbridge could function as a potential site, although an adequately deep sampling location may not be available.

Another priority for augmenting the program would be to expand the spatial and/or temporal sampling of the streams already selected for monitoring. A number of point measurements above and below the fixed monitoring stations and a cross-section at the current monitoring station could be taken to determine the variability of water quality parameters in adjacent, same-stream reaches.

7.2 Adding New Sampling Strategies

One relatively easy and low-cost program improvement would be to establish water temperature monitoring in multiple GLBA streams. Low-cost temperature loggers (such as StowAway TidbiTs, about \$200 each as of August 2011) could be placed in streams and left unattended for many months before downloading. Each TidbiT can store nearly 8,000 data points at custom time intervals over five years of battery life before downloading is necessary. Once downloaded, the memory can be reset. These would provide a valuable water temperature record for streams exposed to important environmental forces such as glacial melt and long-term climate change. Water temperature can be linked to other important environmental parameters such as changes in water chemistry or organism growth and survival (e.g., maturation timing of salmonid eggs). Before pursuing expanded water temperature monitoring in GLBA, a more formal scoping process would be initiated between the SEAN and park staff.

7.3 Integrating Core Water Quality Data with Other Studies and Vital Signs

As the SEAN water quality data set grows over time, there will be opportunities for using these data to support investigations that extend beyond the scope of our annual and five-year reports.

It is well-established that streamflow is highly correlated with and drives patterns in water quality parameters. Currently, streamflow is measured in the same location as water quality at KLGO and SITK. The KLGO gage at Taiya River is operated by USGS under a cooperative funding agreement between NPS, City of Skagway, and USGS. The SITK gage at Indian River is currently operated by NPS but does not have a formal data collection protocol or data QA/QC process. The Salmon River in GLBA has no current gaging facilities, but one may be considered as part of a future Vital Signs program expansion (as of March 2013, the Alaska Department of Transportation was considering installing a gage on the Salmon River). When data are available, annual water quality reporting will include streamflow comparisons. After a Streamflow Vital Signs program is finalized, it will be determined if combining streamflow and water quality into a single annual report is desirable. Five-year synthesis reports will consider comparisons between streamflow and water quality to the extent data collection and quality allows.

The effects of development may be apparent from water quality trends. The Indian River is partially urbanized upstream of the SITK boundary. Some water diversion occurs in the Indian River and may have potentially harmful effects on the stream ecosystem. Water temperatures may rise with lower flows in the summer and drop more easily with freezing air temperatures in the winter. DO may decrease due to increased fine sediment inputs, algae, lower flow levels, and/or increased summer temperatures. Watershed development may increase acute surface runoff events due to increased impervious surfaces such as asphalt and concrete, and it may also lead to chronic and/or acute influxes of contaminants from inputs such as oil and grease. These issues will be addressed in the freshwater contaminants vital sign monitoring protocol that is currently under development. In addition to water quality impacts, urban development can alter in-stream habitat by decreasing the recruitment of large woody debris (LWD), increasing bank erosion, modifying natural flow regimes, and increasing the probability of introducing invasive species.

The invasive diatom *Didymosphenia geminata*, of considerable concern at SITK, may spread and thrive at warmer temperatures and suppress DO levels in streams. Research on linkages between terrestrial and aquatic systems suggests that elevated surface temperatures and carbon dioxide levels will affect the distribution and productivity of plants, in turn affecting the amount and quality of leaf litter and woody debris entering streams and causing fluctuations in stream oxygen levels (Meyer and Pulliam 1992, Sweeney et al. 1992). In addition, surface water quality could also be altered by predicted changes in the frequency of disturbances such as wind storms and coastal floods (Meyer and Pulliam 1992, Parson et al. 2000). Ultimately, changes to the quality and quantity of runoff from terrestrial ecosystems may affect nearshore marine systems in and around SEAN parks, especially in terms of supporting anadromous fish populations and supplying important terrestrial nutrients to coastal regions (Hood and Scott 2008). All of these hypotheses can be investigated using the future SEAN water quality data set.

8. Literature Cited

- Alaska Department of Environmental Conservation (ADEC). 2010. Alaska's final 2010 integrated water quality monitoring and assessment report, July 15, 2010. Available at http://dec.alaska.gov/water/wqsar/Docs/2010_Integrated_Report_Final_20100715_corrected_july_19.pdf (accessed March 2013)
- Alaska Department of Environmental Conservation (ADEC). 2012. Water quality standards (18 AAC 70) amended as of April 8, 2012. Alaska Department of Environmental Conservation, Anchorage, Alaska. Available at <http://dec.alaska.gov/commish/regulations/pdfs/18%20AAC%2070.pdf> (accessed March 2013)
- Chapin, F. S., L. R. Walker, C. L. Fastie, and L. C. Sharman. 1994. Mechanisms of primary succession following deglaciation at Glacier Bay, Alaska. *Ecological Monographs* **64**:149–175.
- Danielson, S., W. Johnson, L. Sharman, G. Eckert, and B. Moynahan. 2010. Glacier Bay National Park and Preserve oceanographic monitoring protocol: Version OC–2010.1. Natural Resource Report NPS/SEAN/NRR—2010/265. National Park Service, Fort Collins, Colorado.
- Eckert, G., E. Hood, S. Nagorski, and C. Talus. 2006a. Assessment of coastal water resources and watershed conditions at Glacier Bay National Park and Preserve, Alaska. National Park Service Water Resources Division Technical Report NPS/NRWRD/NRTR-2006/353. National Park Service, Fort Collins, Colorado. Available at http://science.nature.nps.gov/im/units/sean/AuxRep/0_SEAN/0_Coastal%20Watershed%20Assessment%20Final%20GLBA.pdf (accessed March 2013).
- Eckert, G., E. Hood, C. Talus, and S. Nagorski. 2006b. Assessment of coastal water resources and watershed conditions at Sitka National Historical Park, Alaska. National Park Service Water Resources Division Technical Report NPS/NRWRD/NRTR-2006/347. National Park Service, Fort Collins, Colorado. Available at http://science.nature.nps.gov/im/units/sean/AuxRep/0_SEAN/0_Coastal%20Watershed%20Assessment%20Final%20SITK.pdf (accessed March 2013).
- Engstrom, D. R., S. C. Fritz, J. E. Almendinger, and S. Juggins. 2000. Chemical and biological trends during lake evolution in recently deglaciated terrain. *Nature* **408**:161–166.
- Gustavus Electric Company. 2004. Final environmental impact statement: Glacier Bay National Park and Preserve, Falls Creek hyroelectric project and land exchange. FERC Project No. 11659-002. U.S. Federal Energy Regulatory Commission, Office of Energy Projects, Washington, D.C.
- Hem, J. D. 1985. Study and interpretation of the chemical characteristics of natural water. USGS Water-Supply Paper 2254. Alexandria, Virginia. 263 pp.

- Hood, E., G. Eckert, S. Nagorski, and C. Talus. 2006. Assessment of coastal water resources and watershed conditions at Klondike Gold Rush National Historical Park, Alaska. National Park Service Water Resources Division Technical Report NPS/NRWRD/NRTR-2006/349. Available at http://science.nature.nps.gov/im/units/sean/AuxRep/0_SEAN/0_Coastal%20Watershed%20Assessment%20Final%20KLGO.pdf (accessed March 2013).
- Hood, E., and D. Scott. 2008. Riverine organic matter and nutrients in southeast Alaska affected by glacial coverage. *Nature Geoscience* **1**:583–587.
- Irwin, R. J. 2004. Draft part B of aquatic habitat park service guidance for park service vital signs monitoring. Planning process steps: Issues to consider and then to document in a detailed study plan that includes a quality assurance project plan (QAPP) and monitoring "protocols" (standard operating procedures). National Park Service, Water Resource Division, Fort Collins, Colorado. Available at <http://science.nature.nps.gov/im/monitor/protocols/wqPartB.doc> (accessed March 2013).
- Johnson, W. F., and B. J. Moynahan. 2008. Data management plan: Southeast Alaska network. Natural Resource Report NPS/SEAN/NRR—2008/058. National Park Service, Fort Collins, Colorado.
- Meyer, J. L., and W. M. Pulliam. 1992. Modification of terrestrial-aquatic interactions by a changing climate. Pages 177–191 in Firth, P., and S. G. Fisher, editors. *Global climate change and freshwater ecosystems*. Springer-Verlag, New York.
- Milner, A. M., C. L. Fastie, F. S. I. Chapin, D. R. Engstrom, and L. C. Sharman. 2007. Interactions and linkages among ecosystems during landscape evolution. *BioScience* **57**:237–247.
- Moynahan, B. J., W. F. Johnson, D. W. Schirokauer, L. Sharman, G. Smith, and S. Gende. 2008. Vital sign monitoring plan: Southeast Alaska Network. Natural Resource Report NPS/SEAN/NRR—2008/059. National Park Service, Fort Collins, Colorado.
- Nagorski, S., and E. Hood. 2007. Technical assistance in evaluating, summarizing, and developing the water quality monitoring component of the National Park Service's Southeast Alaska Network Inventory and Monitoring Program. Unpublished Report to the National Park Service. 58 pp.
- Nagorski, S., D. Engstrom, J. Hudson, D. Krabbenhoft, J. DeWild, E. Hood, and G. Aiken. 2011. Scale and distribution of global pollutants in Southeast Alaska Network park watersheds. Natural Resource Technical Report NPS/NRWRD/NRTR—2011/496. National Park Service, Fort Collins, Colorado.
- Neal, E. G., T. P. Brabets, and S. A. Frenzel. 2004. Water quality and streamflow of the Indian River, Sitka, Alaska, 2001–2002. U.S Geological Survey Scientific Investigation Report. Anchorage, Alaska.

- National Park Service (NPS). 1995. Baseline water quality data inventory and analysis, Glacier Bay National Park and Preserve. Water Resources Division Technical Report NPS/NRWRD/NRTR-95/56. National Park Service, Water Resource Division, Fort Collins, Colorado.
- National Park Service (NPS). 1998a. Baseline water quality data inventory and analysis, Klondike Gold Rush National Historical Park. Water Resources Division Technical Report NPS/NRWRD/NRTR-98/160. National Park Service, Water Resource Division, Fort Collins, Colorado.
- National Park Service (NPS). 1998b. Baseline water quality data inventory and analysis, Sitka National Historical Park. Water Resources Division Technical Report NPS/NRWRD/NRTR-98/182. National Park Service, Water Resource Division, Fort Collins, Colorado.
- National Park Service (NPS). 2005. Freshwater ecosystems monitoring scoping workshop notebook. National Park Service, Southeast Alaska Inventory and Monitoring Network, Juneau, Alaska.
- Parson, E. A., L. Carter, P. Anderson, B. Wang, and G. Weller. 2000. Chapter 10: Potential Consequences of Climate Variability and Change for Alaska. Pages 283–312 *in* U.S. Global Change Research Program, National Assessment Synthesis Team, editors. Climate change impacts on the United States: The potential consequences of climate variability and change. Cambridge University Press, New York.
- Sergeant, C.J., and W. F. Johnson. 2013. Southeast Alaska Network freshwater water quality monitoring program: 2012 annual report. Natural Resource Technical Report NPS/SEAN/NRTR—2013/706. National Park Service, Fort Collins, Colorado.
- Shannon & Wilson, Inc. 1995. Environmental Site Assessment, Indian River Asphalt Site, Sitka National Historical Park, Sitka, Alaska. Shannon & Wilson, Inc., Fairbanks, Alaska.
- Shearer, J., and C. Moore. 2011. Southwest Alaska freshwater flow system monitoring protocol narrative, Southwest Alaska Network. Natural Resource Report NPS/AKR/SWAN/NRR—2011/XXX. National Park Service, Fort Collins, Colorado. Available at http://science.nature.nps.gov/im/units/swan/assets/docs/reports/protocols/aquatic/SWAN_Freshwater_Flow_System_Protocol_Narrative_DRAFT_20110114.pdf (accessed March 2013)
- Soiseth, C. R., and A. M. Milner. 1995. Predicting salmonid occurrence from physical characteristics of streams in Glacier Bay National Park and Preserve. Pages 174–183 *in* D. R. Engstrom, editor. Proceedings of the Third Glacier Bay Science Symposium, 1993. National Park Service, Anchorage, Alaska.
- Sweeney, B. W., J. K. Jackson, D. Newbold, and D. H. Funk. 1992. Climate change and the life histories and biogeography of aquatic insects in eastern North America. Pages 143–176 *in* Firth, P., and S. G. Fisher, editors. Global climate change and freshwater ecosystems. Springer-Verlag, New York.

Taiya Inlet Watershed Council. 2006. Pullen Creek Action Plan. Unpublished Report. Skagway, Alaska.

Wagner, R.J., R. W. Boulger, Jr., C. J. Oblinger, and B. A. Smith. 2006. Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3. 51 pp. + 8 attachments. Available at <http://pubs.water.usgs.gov/tm1d3> (accessed March 2013).

SOP 1: Sonde Operation and Field Procedures

Version 2

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
1	March 2013	C. Sergeant	Minor editing, new field sheet images, minor changes to error checking and calibration procedures	2
-	October 2011	B. Moynahan, C. Sergeant.	Initial version	1

Contents

	Page
1.0 Introduction.....	39
2.0 Equipment and Supplies for Sonde Operation.....	39
3.0 Pre-deployment Cleaning and Calibration Procedures	40
4.0 Setting Up and Running EcoWatch for Windows	41
5.0 Pre-deployment Sonde System Setup, Enabling the Sensors, and Setting the Report to Show the Parameters of Interest	41
5.1 Sonde System Setup	41
5.2 Enabling the Sensors.....	42
5.3 Setting the Parameters of Interest	42
5.4 Clearing the Sonde Memory	43
6.0 Setting up the YSI 650 MDS	43
7.0 Monthly Site Integrity Check.....	43
8.0 Data Uploading from the Sonde to the YSI 650 MDS Handheld Unit.....	44
9.0 Sensor Cleaning, Calibration, and Error Checking.....	44
9.1 Overview.....	44
9.2 Sonde Battery Replacement.....	45

Contents (continued)

	Page
9.3 Instructions for Error Checking, Cleaning, Calibration, and Troubleshooting Each Probe	45
9.4 Additional Troubleshooting Procedures	57
10.0 Sonde Storage and Handling.....	57
11.0 Setting up the Sonde to Begin Automated Monitoring.....	58
12.0 Off-season Maintenance and Storage	60

1.0 Introduction

This standard operating procedure (SOP) covers steps for maintenance, deployment, error checking, cleaning, calibration, and storage of the Yellow Springs Instruments (YSI) model 6920V multiparameter sonde with a YSI 650 MDS handheld display/logger (hereafter called the “650”) used in the measurement of the core water quality parameters: water temperature, pH, specific conductivity, dissolved oxygen (DO), and turbidity (in the Taiya River only). If alternate sondes are employed in the future, the appropriate changes will be needed to make this SOP conform to new instrument specifications.

Collecting accurate, precise data requires diligent attention to initial sensor calibration, periodic calibration checks, cleaning of sensors, and proper storage and handling of sensors. The sonde error check and calibration procedures discussed below are drawn from recommendations provided by the instrument manufacturer (YSI), NPS-Water Resources Division, and USGS. They should ensure consistency in quality assurance/quality control (QA/QC) measures for calibration of sondes.

By adhering to the field operation steps below and the annual maintenance, cleaning, and calibration recommendations from the manufacturer, the sondes should perform adequately and the data will meet QA/QC processes by which questionable or erroneous data will be flagged. Due to the added cost and time commitment, this protocol does not require the use of an independent field meter at each park during each field visit, as is recommended or required by some monitoring protocols to pass rigorous tests for within-season checks on instrument fouling and drift. In this protocol, sonde performance relies upon measurements against certified calibration standards. Data evaluation and grading are based on observed sonde fouling error and calibration drift (SOP 2).

Additional information on sonde operation and care is available from the operating manuals on the YSI and the Southeast Alaska Inventory and Monitoring Network (SEAN) websites:

http://science.nature.nps.gov/im/units/sean/FQ_Toolbox.aspx

Hard copies of both manuals were also provided to each park unit with the original sondes. Please ensure that these are always readily available at the office.

2.0 Equipment and Supplies for Sonde Operation

All sondes and sensors are prepared for operation by the Project Leader prior to the initial deployment each season and should not require reassembly upon arriving at each park. The Project Leader follows instructions from the “6-Series Multiparameter Water Quality Sondes User Manual;” this manual can be referenced in the future if any questions arise about pre-season preparation.

All instrument probes must be error checked and calibrated (if necessary) before each field deployment for the 6-month (May 1- October 31) continuous monitoring season. Assuming the sondes are not inaccessible due to streamflow conditions, park leads will check them once per month to download data, clean and assess physical condition of sonde and probes, and assess whether calibrations are needed. Table SOP 1.1 lists equipment and supplies for routine sonde

cleaning and calibration. Additional information on installation and care of probes can be found directly from the manufacturer's operation manuals (YSI 6-series). Park and Project Leads will coordinate the inventory and purchase of necessary supplies each off-season well before the start of sampling in May. Currently, SEAN carries two backup sondes and a full suite of backup sensors for in-season equipment failures.

Table SOP 1.1. Equipment and supplies (a yellow waterproof backpack should be available at each park for transporting gear to field sites).

YSI 6920V2-2 Multiparameter water quality sonde, including
pH probe (YSI 6561)
Dissolved oxygen probe (YSI 6150)
Conductivity/temperature probe (YSI 6560)
Turbidity probe (YSI 6136; <u>Taiya River only</u>)
Required for calibration
NIST-traceable thermometer
5 (or <u>7 for Taiya</u>) 500mL bottles with lids for calibration solutions
pH Standards (4, 7, and 10 standard units)
Conductivity standards (1,000 uS/cm)
Turbidity standards (0 [distilled water] and 126 NTU; <u>Taiya River only</u>)
Bottle of deionized or distilled water
Small covered waste bucket/bottle for transporting used calibration standards
Display unit/logger (YSI 650 MDS Multiparameter Display System) including field cable (YSI 6091, 25 ft.)
Clipboard with covered paper storage
Printed site visit worksheets (laser-printed waterproof paper for the field)
Laminated dissolved oxygen table
Pencils
Eight fresh unused AA-size alkaline batteries
Four fresh unused C-size batteries for 650 logger
Disposable wipes
Squirt bottles
Disposable gloves
Waders and life jacket
Probe cleaning tools: YSI 6570 maintenance kit, soft bristle toothbrush, soft cotton cloths and/or lens cleaning tissues, cotton swabs, dishwashing liquid (e.g., Dawn), small plastic bucket.
Small brush for scrubbing fouling from housing
Large brush for scrubbing fouling from inside of sonde mounting pipe

3.0 Pre-deployment Cleaning and Calibration Procedures

At the start of the field season, even though sensors will have been optimized through factory calibration, cleaning, and repair (if necessary), a full error check and memory clearing should be conducted in the office/lab prior to the seasonal field deployment. Section 9.3 of this SOP details calibration check instructions for each sensor. Memory clearing is explained in section 5.4. The “SEAN FQ site visit worksheet” (Figure SOP 1.1) must be used to record both this initial error check (without the need to fill in the sensor fouling sections) and all subsequent field checks.

The site visit worksheet filled during the pre-deployment check should be carried into the field during deployment in order to record site details.

Before the start of each field season, Park Leads must also be sure to check the condition and expiration dates of each calibration solution to ensure that dirty or expired solutions are never used. The Project Lead will ensure that each sonde has a fresh set of batteries prior to initial field installation.

4.0 Setting Up and Running EcoWatch for Windows

EcoWatch for Windows needs to be installed on an office PC in each park. At this time, Windows 7 and 8 are not compatible with EcoWatch. Please contact the SEAN Data Manager to discuss workaround options. This program has been provided on CD with the original sonde package. It may also be downloaded from www.ysi.com. To install EcoWatch, place the CD into the computer, select **Start**, then **Run** and type **d:\setup.exe** at the prompt. Press **Enter** or click on **“OK”** and the screen will display that EcoWatch is proceeding with the setup. Follow the instructions on the screen as the installation proceeds. Your user ID will typically need administrative rights on an NPS computer to perform the installation.

To run EcoWatch for Windows, select the EcoWatch icon on the desktop or from the Start Menu. For help, refer to section 4 of the “6-Series Multiparameter Water Quality Sondes User Manual.” At this time, only EcoWatch Lite runs properly on the Windows 7 operating system. If you are using EcoWatch Lite, please note the slightly different instructions below.

5.0 Pre-deployment Sonde System Setup, Enabling the Sensors, and Setting the Report to Show the Parameters of Interest

5.1 Sonde System Setup

In the office, the Project Leader connects the sonde to the computer for initial setup. The computer must have an old-style serial DB-9 connector; USB is not supported by YSI. Use the field cable and the sonde-to-PC adapter cable (YSI cable 6095B MS-8/DB-9) to connect the two units. (A 6095B cable is available at the SEAN office in Juneau, but is not routinely stocked at the parks. It is typically used only by the Project Leader to prepare the sonde for a new season.) Be aware that the software within the sonde is separate and different from the EcoWatch software installed on the PC. (If the 6095B cable is not available, initial setup may also be performed using the 650 device, though menu navigation will vary somewhat from that described below.)

Start EcoWatch or EcoWatch Lite from the PC’s Start button. In EcoWatch, select **Comm**, then **Sonde** from the menus to open communication between the PC-based software and the sonde-based software. In EcoWatch Lite, select **File**, then **New Connection**. In EcoWatch, select the proper “com port” radio button and confirm by clicking **OK**. EcoWatch Lite should automatically open the correct port. If you are unsure which com port is being used by the sonde, try each one until you discover one that responds. Once the software recognizes the sonde a “Sonde” window with a # sign appears. The remaining instructions are accurate for both EcoWatch and EcoWatch Lite. Type **“Menu”**, press **Enter**, and the sonde Main menu will be displayed. (If the sonde has been previously used, then the **Main menu**, rather than the # sign, may appear when communication is established, and you will not need to type **“Menu.”**)

The sonde software is menu-driven. Select functions by typing the corresponding numbers. There is no need to press Enter afterwards. Type the **0** or **Esc** key to return to the previous menu.

At the Main menu, select **System**.

Select **1- Date & time**. An asterisk will appear next to each selection to confirm the entry. Select “m/d/y” as the format. Check “4 digit year”. Verify the correct date and time. Local time (Alaska Standard Time [AST] or Alaska Daylight Time [ADT]) is employed. ADT fully covers the current field season (the sonde does not automatically switch between AST and ADT, should the season be extended).

Select **0** to return to the **System setup** menu

Select **4- Instrument ID** from the System setup menu to record the instrument ID/serial number and press **Enter**. Type in the serial number of the sonde at the prompt. The serial number is printed on a waterproof label on the exterior of the sonde. This step may be skipped if the correct serial number is already entered.

Select **0** or **Esc** to return to the **System setup** menu, then press **0** or **Esc** again to return to the **Main menu**.

5.2 Enabling the Sensors

To activate the sensors in the sonde, from **Sonde Main menu**, select **Sensor**. Select numbers corresponding to every sensor that is installed on the sonde. An asterisk will indicate when a sensor is enabled.

Select **0** to return to the **Main menu**

5.3 Setting the Parameters of Interest

To activate the display of specific parameters, select **Report** from the Main menu. You will see a report set up displaying the sensors that are available and enabled on the sonde. *NOTE: These and only these parameters must be enabled.*

Date
Time hh:mm:ss
Temp C
SpCond mS/cm
pH
ODO sat %
ODO mg/L
Battery volts
Turbid+ NTU (Taiya only)

It is essential these exact parameters be specified. Subsequent data management processes require them. For parameters with multiple unit options (e.g., temperature can be reported in degrees Celsius or Fahrenheit), a submenu will appear that allows for the selection of the unit

type. After configuring the display with the correct parameters, press **Esc** or **0** to return to the Main Menu.

5.4 Clearing the Sonde Memory

Before deploying a sonde for the season, previous data must be erased from the flash memory to free up capacity. It also prevents the previous season's data from being duplicated in the data deliverables. To clear the sonde memory, select **File** from the main menu, choose the option "6-Delete all files," and confirm the choice.

NOTE: Be absolutely certain that all prior data have been retrieved and processed before clearing memory. It is not possible to recover sonde data once the memory has been cleared.

6.0 Setting up the YSI 650 MDS

At the start of each season replace the 650 batteries in order to prevent failure in the field; one set of fresh batteries should be adequate. The batteries for the 650 are located at the back of unit. To access, loosen the 4 captive screws using a Phillips or slotted screwdriver and then remove the lid completely. Insert four fresh C cells between the battery clips, being sure to follow the polarity as indicated on the bottom of the battery compartment. Make certain that the gasket is properly installed on the battery lid, reinstall battery lid, tighten the 4 captive screws securely and evenly (using the Phillips or slotted screwdriver). Do not over tighten. It is possible for the batteries to be seated slightly wrong, even after tightening the screws, so if the handheld does not power up, this should be the first item to troubleshoot.

Be sure the settings on the 650 are adjusted for the project purposes prior to the start of the monitoring season. After turning the instrument on to display the **650 Main menu**, use the arrow keys to highlight the **System setup** selection and press **Enter** (the enter key has a small arrow with 90-degree bent line). Set '**Date & Time**' to match the sonde as specified in 5.1. Press the **Esc** key to return to the System setup menu.

Highlight the **Shut off time (minutes)** selection to change the number of minutes programmed that the 650 waits to shut down to save batteries. Values can be integers (20 minutes is recommended). Do not enter "0" which disables the shutoff completely

Highlight the **Instrument ID** selection and press Enter. Under the "System setup" menu that then appears, scroll down to "ID=" and input (using the alphanumeric keys) "YSI 650". Press **Esc** and return to the **650 Main menu**.

Several other setup options are available though not commonly used; refer to pages 3-19 to 3-20 in the 6-Series user manual.

7.0 Monthly Site Integrity Check

Upon arriving at the water quality monitoring site, and before initiating any of the monthly data downloads and fouling/calibration checks on the sensors, Park Leads should make a few general notes at the top section of the "SEAN FQ site visit worksheet" (Figure SOP 1.1) regarding the physical condition of the site. Near the top of the worksheet, under "Site and sonde conditions", the Park Lead needs to indicate if the physical integrity of the site is good or not, if the sonde is accessible due to flow conditions, and if so, whether the battery supply is adequate or was spent

since the last site visit. At the Salmon River site, staff should check to see if the angle-iron mount is secure and vertical; at the Indian and Taiya River sites, staff should make sure that the stabilizing bolts to the bedrock are holding. Any problems should be indicated on the appropriate “comments” line on the sheet and repaired as soon as possible. The Park Lead should also check the pipe housing for debris or fouling and take the appropriate measures to clean it both inside and outside if necessary. A toilet bowl brush with an extended handle or small diameter fireplace chimney brush works well to clean the inside of the pipe.

8.0 Data Uploading from the Sonde to the YSI 650 MDS Handheld Unit

Unless this is the first site visit for the monitoring season, the next step after a general site integrity check is to connect the field cable and upload data to the 650. The procedure for uploading the month’s collection of continuous water quality data off the sonde in the field and sending the data to the Project Leader from the office is detailed in SOP 3.

9.0 Sensor Cleaning, Calibration, and Error Checking

9.1 Overview

Before the season’s initial deployment the sonde has already been properly calibrated as described in section 3.0, so this does not need to be done in the field. For subsequent visits, after the Park Lead has uploaded data from the sonde to the 650 according to SOP 3, the next step is to check each sensor and to restore performance, if necessary, through cleaning and/or recalibration.

Sensor readings can undergo measurement drift over the course of extended use, so it is important to quantify this drift and recalibrate the sensors, if needed, to maintain accurate and precise performance. The sensors are susceptible to fouling over time, even those equipped with automatic wipers. If probes are fouled, their performance is compromised, and therefore most probes will need to be cleaned periodically during the monitoring season. The Project Lead ensures that Park Leads have the cleaning supplies necessary to properly clean the instruments.

Before performing any calibration procedure, the sonde and display must stabilize (warm-up) at least 15 minutes. In most cases, the sonde will not need to warm-up because of its continual deployment in the field; however, warm-up is necessary during the initial calibration and during any subsequent events when it is turned off for more than a few minutes (e.g., following a battery failure or change).

During the warm-up period, check the battery level of the sonde using the 650. Connect the powered up 650 to the sonde, highlight “Sonde Run,” using the arrow keys, press **Enter**, and the display screen will show the properties of the sonde itself, and not the 650. Confirm this by looking for the “sonde” display icon on the bottom right hand corner. If either the gauge shows less than half a charge or if this is halfway through the season (July site visit), the sonde batteries need to be replaced to avoid future data loss and potential corrosion caused by aging, leaky batteries (section 9.2).

During error checking, probes are typically rinsed with distilled water before and after immersion in the calibration solutions. Because specific conductance and pH are temperature-dependent, the entire temperature probe must be covered with solution during calibration of the

conductivity and pH probes. Dissolved oxygen is also temperature-dependent, but it is calibrated with a water-saturated air procedure, and the sensor is not immersed in solution. Detailed error checking and calibration instructions are provided below.

When conducting calibrations in the field, personnel must be sure to store used calibration standard solutions in a waste bucket or bottle with a lid so that all waste material is properly poured down a sink drain with running tap water and not disposed of at the study site.

The full “SEAN_FQ site visit worksheet” (Figure SOP 1.1) must be printed off in the park unit office prior to the site visit so that the Park Leads can fill them out with a pencil in the field. Print the waterproof paper worksheet on a laser, not inkjet, printer; most inkjet ink dissolves in rain. A protective clipboard/case will protect the sheet from inclement weather. On return, the Park Lead will then need to enter the data into the electronic version of the site visit worksheet. This MS Excel formatted file will later be transferred to the Project Leader as FQ_C (see instructions in SOP3). The file naming convention for this electronic field form is: FQ_C_4-letter park code_2-letter site code_site_visit_date.xlsx. For example:

FQ_C_SITK_IN_SITE_VISIT_20100604.XLSX.

Site codes are IN for Indian River, SA for Salmon, and TA for Taiya.

When completing this worksheet, all dates and times must reflect the GMT-8 time zone, which currently coincides with Alaska Daylight Time. If the visit occurs after daylight time ends in November, dates and times must still reflect GMT-8 / ADT. This ensures the worksheet grades can be properly applied to the sonde data points, as sonde data are always stamped using GMT-8.

9.2 Sonde Battery Replacement

The battery lid is located on the top of the sonde. Position the bail perpendicular to the sonde and use it as a lever to unscrew the battery cap by hand. Then slide the battery lid up and over the bulkhead connector. Replace batteries with 8 AA-size alkaline batteries. Pay attention to the orientation of the spent batteries and reinstall fresh batteries using the correct polarity. Make sure there are no contaminants between the O-ring and the sonde. Lightly lubricate the o-rings on the bottom of the threads and on the connector stem using the lubricant included in the YSI 6570 maintenance kit. Return the battery lid and tighten by hand, without over tightening.

9.3 Instructions for Error Checking, Cleaning, Calibration, and Troubleshooting Each Probe

The instructions below correspond to the data entry prompts for the “SEAN WQ site visit” worksheet (Figure SOP 1.1). It is important to ensure you are using the most recent version of the worksheet, which can always be found at the SEAN water quality toolbox:

http://science.nature.nps.gov/im/units/sean/FQ_Toolbox.aspx

Worksheets will typically be filled out with a pencil in the field, and then entered electronically after the site visit. Note that in the electronic version, solid yellow boxes must be filled in manually by the user, while lighter yellow gradient boxes will be filled automatically.

When conducting these calibrations and checks, the sonde needs to be connected to the 650 via the field cable. Turn the 650 on, and you will be in the “650 Main menu.” Select **Sonde Run**, press Enter, and note that the icon on the bottom right has changed from the 650 to the sonde. In this mode, you will see the live display of the values of the selected parameters being measured off the sonde. Hit the **Esc** key at any time to return to the Main menu.

SEAN Freshwater Water Quality Monitoring		Contact: Project Leader: Chris Sergeant	
Site Visit Worksheet		National Park Service - SEAN	
Version 2013-03-26		Sonde Serial # (Check One)	3100 National Park Road
			Juneau, AK 99801
Date of this visit		08H100353	phone: (907) 364-1541
Operator		08H100354	email: Christopher_Sergeant@nps.gov
Site name		08H100355	
SITE AND SONDE CONDITIONS			
Physical integrity of site ok?		If no, comment:	
Sonde accessible? (Yes/No)		If no, comment:	(If not accessible, end worksheet here)
Time sonde pulled (hh:mm)		Time redeployed:	
Battery replaced? (Yes/No)		If yes, did battery fail since last visit?	Battery replacement: SOP 1, Section 9.2
Upload data to 650 MDS unit and scan most recent entries. Obvious that data quality is questionable? (Yes/No)			
FOULING AND CALIBRATION CHECKS AND CORRECTIONS -- USE SOP 1, Section 9			
TEMPERATURE - SOP 1, Section 9.3.1			
(Single Point Error Check with NIST-Certified or NIST-Traceable Thermometer; Calibration done by manufacturer prior to field deployment)			
Water Temp (NIST thermometer)			
Water Temp (YSI sonde)			
Error			
Within allowable error range: +/- 1? (Yes/No)		If no, contact Project Leader for replacement.	
Comments:			
SPECIFIC CONDUCTANCE - SOP 1, Section 9.3.2			
<u>Standard</u>	<u>Sonde Reading prior to cleaning and recalibration</u>	<u>Within allowable error range? (Yes/No)</u>	
1000 us/cm ref standard		(between 950-1050?)	
If allowable, specific conductance check completed. If not allowable, clean probe, and remeasure:			
<u>Standard</u>	<u>Sonde Reading following cleaning</u>	<u>Within allowable error range? (Yes/No)</u>	
1000 us/cm ref standard		(between 950-1050?)	
If allowable, specific conductance check completed. If not allowable, ensure probe is clean, and perform recalibration:			
<u>Standard</u>	<u>Sonde Reading following calibration</u>	<u>Within allowable error range? (Yes/No)</u>	
1000 us/cm ref standard		(between 950-1050?)	
post-calibration K-cell constant		(acceptable high range conductivity K-cell = 5.0 ± 0.5)	
Recalibrate again? (if yes, override cells above with new calibration) Yes/No			
Comments			

Figure SOP 1.1. SEAN freshwater water quality monitoring site visit worksheet (version March 26, 2013).

pH - SOP 1, Section 9.3.3					
Sonde Reading prior to cleaning and recalibration					
Standard	pH reading	°C reading	Expected pH (from table)	Error (expected-reading)	Allowable range? (error <= 0.1)
7.00					
10.00					
If allowable, pH check completed. If not allowable, clean probe, and remeasure:					
Sonde Reading following cleaning					
Standard	pH reading	°C reading	Expected pH (from table)	Error (expected-reading)	Allowable range? (error <= 0.1)
7.00					
10.00					
If allowable, specific conductance check completed. If not allowable, ensure probe is clean, and perform recalibration:					
Sonde Reading following calibration					
Standard	pH reading	°C reading	Expected pH (from table)	Error (expected-reading)	Allowable range? (error <= 0.1)
7.00					
10.00					
4.00					
Recalibrate again? (if yes, override cells above with new calibration) Yes/No					
Comments					
DISSOLVED OXYGEN - SOP 1, Section 9.3.4					
(Check calibration using water saturated air method)					
Temperature		° C			
Barometric pressure		mmHG			
Calculated DO Level		mg/L	(Refer to DO saturation table if in the field)		
DO meter reading		mg/L			
Allowable?		(allowable if within 0.5 mg/L of calculated value)			
If allowable, DO check completed. If not allowable, clean probe, and remeasure:					
Sonde Reading following cleaning					
DO meter reading		mg/L			
Allowable?		(allowable if within 0.5 mg/L of calculated value)			
If allowable, specific conductance check completed. If not allowable, ensure probe is clean, and perform recalibration:					
Sonde Reading following calibration					
DO meter reading		mg/L			
Allowable?		(allowable if within 0.5 mg/L of calculated value)			
Recalibrate again? (if yes, override cells above with new calibration) Yes/No					
Comments					
TURBIDITY (Taiya River only) - SOP 1, Section 9.3.5					
Standard	Sonde Reading prior to cleaning and recalibration			Within allowable error range? (Yes/No)	
0 NTU ref (distilled water)				(between 0.0-0.5?)	
126 NTU ref standard				(between 119-133?)	
If allowable, turbidity check completed. If not allowable, clean probe, and remeasure:					
Sonde Reading following cleaning					
Standard				Within allowable error range? (Yes/No)	
0 NTU ref (distilled water)				(between 0.0-0.5?)	
126 NTU ref standard				(between 119-133?)	
If allowable, specific conductance check completed. If not allowable, ensure probe is clean, and perform recalibration:					
Sonde Reading following calibration					
Standard				Within allowable error range? (Yes/No)	
0 NTU ref (distilled water)				(between 0.0-0.5?)	
126 NTU ref standard				(between 119-133?)	
Recalibrate again? (if yes, override cells above with new calibration) Yes/No					
Comments					

Figure SOP 1.1. SEAN freshwater water quality monitoring site visit worksheet (continued).

9.3.1. Temperature

Each probe (except turbidity) relies on temperature readings for accurate measurements; therefore, the temperature sensor should be checked prior to calibration of the other sensors. Although the sonde temperature sensor is very reliable, it must be error-checked against a National Institute of Standards and Technology (NIST)-certified or -traceable thermometer before each field deployment.

Note: The accuracy comparison of $\pm 1.0^{\circ}\text{C}$ in this SOP is based on the quality of the NIST-traceable thermometers. This thermometer is not necessarily more accurate than the YSI probe. The purpose of comparing the YSI probe to a NIST-traceable thermometer is to get a general, although not highly accurate, validation of the temperature measurements.

Calibration:

The temperature sensor cannot be calibrated. If it fails, it must be replaced.

Error Checking:

1. Prepare a container filled with water (either tap water if performing check in the lab/office, or with stream water if working in the field).
2. Next, place the NIST thermometer and sonde into the water, wait for both temperature readings to stabilize, and record the temperature values on the worksheet. (Note: On the 650, you will need to be in the 650 Main Menu/ Sonde Run mode to view the temperature readings off the sonde).
3. Compare the two measurements. The sonde's temperature sensor must agree with the reference thermometer within $\pm 1.0^{\circ}\text{C}$. If the measurements do not agree, the instrument may not be working correctly and the Project Leader must be contacted.

Troubleshooting:

The temperature probe should be relatively trouble-free. If a discrepancy between a NIST thermometer and sonde temperature sensor in liquid is greater than 1.0°C , the cause must be investigated. On the YSI 6920 sondes, remove the 6560 temperature / conductivity probe (refer to the YSI user manual for proper removal and installation technique). The sonde display should read -9.99°C with the probe removed. If the display reads any number other than -9.99°C , contamination of the port or circuit malfunction is the most likely cause. Follow the sonde port connector cleaning procedures available from the manufacturer. If cleaning the sonde port connector does not solve the problem, factory servicing is needed.

9.3.2. Specific Conductance/ Conductivity

Conductivity is a measure of the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected at 25°C . In the event of an uncorrected sensor recording where only conductivity can be measured, specific conductivity can be calculated using conductivity and water temperature:

$$C_{25} = C_m / (1 + 0.019(tm - 25))$$

Where, C_{25} =corrected conductivity value adjusted to 25°C

C_m =actual conductivity measured before correction; and

tm =water temperature at time of C_m measurement

Error checking, cleaning, and calibration:

Perform a single point error check with the 1,000 uS/cm YSI solution. The 1,000 uS/cm solution from YSI is the recommended standard for specific conductivity calibrations. This new single point error check was implemented at the beginning of the 2013 season. See the previous protocol for past two-point error checking routines.

Important: when the sonde has been installed in the field, do not clean the probe before performing this initial error check. This check allows for determination of sensor drift since the last error check.

1. Triple rinse all sensors with deionized or distilled water; excess water may be dabbed with a towel
2. Fill the calibration cup with enough 1,000 uS/cm solution to submerge the temperature and conductivity probes, and insert the probes. (Important: make sure that no air bubbles are trapped inside the conductivity cell.) It may help to invert the sonde once the calibration cup is screwed back on so that less calibration standard is used. Alternatively, since conductivity and temperature are measured on the same probe, you may fill the Project Lead-supplied scintillation vial with standard and slide that over the probe. Select Sonde Run.
3. Once stabilized, record the specific conductivity value as “Sonde Reading prior to cleaning and recalibration” for the 1,000 uS/cm solution.
4. If the results are within 5% of the known standard value (between 950 and 1050 uS/cm), you may move on to checking pH. Any obvious buildup on the sensor may be cleaned at this time. If the results are not within 5% of the known standard value, then clean the probe per instructions below.
5. Probe cleaning: If the openings on the probe have biofouling or trapped sediment, they can be gently rinsed with deionized or distilled water directed through the openings using the syringe provided with the 6570 YSI maintenance kit, or else with a squirt bottle. Oily, salty, or other chemical residues can be removed using a biodegradable detergent solution. Additionally, use the small cleaning brush in the Maintenance Kit by dipping it in clean water and brushing the openings (those that allow fluid access to the conductivity electrodes) 15–20 times. Mild detergent may be used with the brush if oily, salty, or other chemical residues have formed deposits on the electrodes.
6. Repeat steps 1–3, recording the new reading under “sonde reading following cleaning”
7. If the results are still not within 5% of the known standard values, the sensor should be recalibrated, as instructed below.
8. Calibration instructions:
 - a) Rinse all probes with deionized or distilled water.
 - b) Pour a small amount (approx. 25 mL) of 1,000 uS/cm solution in the calibration cup, thread the cup onto the sonde, shake the sonde rinsing the sensors with solution, then discard solution.
 - c) Fill the calibration cup or scintillation vial with enough 1,000 uS/cm solution to submerge the temperature and conductivity probes, and insert the probes.
Important: ensure that no air bubbles are trapped inside the conductivity cell.
 - d) From the sonde display main menu, select Sonde Menu / Calibrate / Conductivity / SpCond, and press Enter.

- e) Enter the standard concentration 1.000 mS/cm and press Enter. Important: double check that the concentration is entered as milli-Siemens /cm, not micro-Siemens/cm.
 - f) After the specific conductivity reading has stabilized, press Enter and wait for the “Calibrated” message to appear. Record the “calibrated” value in the comments section of the field sheet.
12. Record the K cell constant by selecting Sonde Menu / Advanced / Cal Constant.
 13. Check the calibration by reading the 1,000 uS/cm standard by repeating steps 1–3, and recording the result in the “sonde reading following calibration” column.
 14. If the results are not within 5% of the known standard values, then recalibrate the probe. If repeated calibration does not result in satisfactory performance, go to Troubleshooting, below.

Troubleshooting: The conductivity K cell constant generated during calibration should be used as an indicator of potential problems. The K cell constant should be 5.0 ± 0.5 . Any significant change in this number between readings of different conductivity solutions indicates a potential problem. First, check to make sure proper calibration procedures were followed and that the conductivity solutions are not expired. The conductivity value should read 0.00 (or very close to it) when either in distilled water or when dried and in air. If the probe reports a conductivity value when placed in a non-conductive medium, remove the 6560 temperature / conductivity probe (CAUTION: removing the probe from the port can be tricky if the probe has been deployed for some time. Fine sediments may have lodged in the port connectors, making it difficult to remove the probe without breaking the connector pins. If you come across resistance removing the probe, consider not removing it for this troubleshooting exercise and waiting for factory servicing). Refer to the YSI User Manual for more detailed removal instructions. With the probe removed, the sonde display should read -9.99°C for temperature and 0.00 + 10 uS/cm for conductivity. If the conductivity immediately drops when the probe is removed, then the probable cause is water leakage into the sensor. If the conductivity reading remains, clean the probe and port.

9.3.3 pH

The pH of a sample is determined electrometrically using a glass electrode. For SEAN rivers, expected values will fall between pH 6 and pH 9. The calibration procedure below will outline the steps for a 2-point calibration with pH 7 and pH 10 and an error check using pH 4 solution. Always calibrate with pH 7 first. Important: when the sonde has been installed in the field, do not clean the probe before performing this initial error check. This check allows for determination of sensor drift since the last error check.

Error checking, cleaning, and calibration:

1. Triple rinse all of the probes on the sonde with deionized or distilled water. Shake off excess water or dab lightly with a towel.
2. Rinse all probes with a small amount of pH 7 solution.
3. Fill the calibration cup with enough pH 7 solution to submerge the temperature and pH probes, and insert the probes. It helps to invert the sonde so that less calibration

standard is used. Alternatively, the probes can be dipped into a soft pastic bag such as a whirlpack. Select Sonde Run.

4. Based on the temperature displayed on the 650, record the temperature-corrected expected value for pH 7 and pH 10 buffers in the appropriate field sheet boxes. Note that the electronic field sheet will automatically fill these values. The pH buffer labels on each bottle list the temperature-corrected values, but below is the same table for reference. Choose the expected value that is closest to the temperature you are currently reading on the 650 (e.g., if the pH standard is 12°C, choose the expected value for 10°C).

Oakton brand temperature-corrected pH buffer values

°C	pH 4.0	pH 7.0	pH 10.0
0	4.00	7.11	10.32
10	4.00	7.06	10.18
20	4.00	7.01	10.06

5. Once stabilized, record the pH value under “Sonde Reading prior to cleaning and recalibration” for the pH 7 solution. Stabilization can take up to 2 or 3 minutes under warmer or colder conditions.
6. Rinse all probes on the sonde with deionized or distilled water. Shake off excess water or dab lightly with a towel.
7. Rinse sensors with small amount (approx. 25 mL) of pH 10 solution. This can be achieved using a squirt bottle filled with solution, or by pouring a small amount in the calibration cup, threading it onto the sonde, and swirling it vigorously.
8. Repeat step 3, but with pH 10 solution, allow measurements to equilibrate, then write down result of the measurement on the log sheet (also under “Sonde Reading prior to cleaning and recalibration”, but for the pH 10 solution.)
9. Check if both pH 7 and pH 10 buffers read back to within 0.10 pH units of the temperature-corrected expected buffer values. If they do, the pH sensor checks out fine and can be redeployed as is. You can clean any obvious buildup on the sensor at this time. If the sensors were not in range, clean the sensor according to directions below.
10. Probe cleaning: Use clean water and a soft clean cloth, lens cleaning tissue, or cotton swab to remove all foreign material from the glass bulb and platinum button or ring. Then use a moistened cotton swab to carefully remove any material that may be blocking the reference electrode junction of the sensor. (Caution: Be certain not to damage the glass bulb. If using a swab, do not force it between the probe guard and glass). If this does not adequately restore the performance of the probe: (1) Soak the probe for 10–15 minutes in clean water containing a few drops of biodegradable liquid dishwashing detergent; (2) GENTLY clean the glass bulb and platinum button by rubbing with a cotton swab soaked in the cleaning solution; (3) Rinse the probe in clean water, wipe with a cotton swab saturated with clean water, and then re-rinse with clean water.
10. Repeat steps 1–9, recording the new readings under “sonde reading following cleaning”

11. If the results are still not within 0.1 pH units of the temperature-corrected expected buffer values, the sensor should be recalibrated, as instructed below.

12. Calibration instructions:

- a) Allow the buffered samples to equilibrate to the ambient temperature. Ideally, calibration solutions should mimic temperatures likely to be experienced in the field.
- b) Triple rinse all of the probes with deionized or distilled water. Shake off excess water or dab lightly with a towel.
- c) Pour a small amount (approx. 25 mL) of pH 7 buffer in the calibration cup, thread the cup onto the sonde, shake the sonde rinsing the sensors with solution, then discard buffer. Repeat this step two more times.
- d) Fill the calibration cup with enough pH 7 calibration solution to submerge the temperature and pH probes, and insert the probes.
- e) Select Sonde Menu / Calibrate / ISE1 pH / 2 point.
- f) Input temperature-corrected expected buffer value and press Enter.
- g). Wait for the value of pH to stabilize, and press Enter. Wait for "Calibrated" message and record the pH value as the "Sonde reading following calibration." If an "Out of Range" message appears, do not accept.
- h). Triple rinse probe and calibration cup with deionized or distilled water and shake off excess water.
- i) Triple rinse the sensors and calibration cup with pH 10 buffer similar to Step 3 above.
- j) Fill the calibration cup with pH 10 calibration standard and immerse the probes. Press Enter.
- k). When prompted, enter the temperature-corrected expected buffer value, wait for "Calibrated" message, record the pH value as the "Sonde reading following recalibration," and press Enter to continue.

13. Check the calibration by performing readings of the pH 4 standard by repeating steps 1–9, and filling in the results in the "sonde reading following calibration" column.

14. If the post-calibration readings of the 3 standards are not within 0.10 units of the temperature-corrected expected buffer values, then recalibrate the probe. Record the pH millivolt values in the comments section of the field sheet. If repeated calibration does not result in satisfactory performance, go to Troubleshooting, below. At this point, it is likely that a large amount of standard has been used. Contact the Project Leader as soon as possible if more standard is needed for future error checking.

Troubleshooting: Use the slope of the pH sensor based on the pH millivolt values as a diagnostic key. The slope is calculated by determining the difference between the two calibration point millivolt readings (i.e., pH 7 millivolts – pH 10 millivolts *or* pH 4 millivolts – pH 7 millivolts). Millivolt values should be as follows: pH 4=180 ± 50 mv; pH 7=0 ± 50 mv; pH 10=-180 ± 50 mv. The acceptable range for slope is 165 to 180. If the slope drops below 160, the sensor should be taken out of service.

pH standards are highly buffered and provide optimal pH measurement conditions, unlike poorly buffered environmental waters. Low ionic strength waters with a specific conductivity < 50 uS/cm may cause pH measurement stability problems with some probes, resulting in the probe to drift slowly in one direction up to several hundredths of a

pH standard unit per minute. If this situation occurs, a low ionic strength sensor must be used. Often, probes will calibrate fine in high ionic strength buffers, but will not read accurately in lower ionic strength waters. Using low ionic strength buffers can remedy this problem.

For further details on making accurate pH measurements, YSI has a relatively informative PowerPoint presentation available online:
<http://www.ysi.com/media/support/YSI-Making-Good-pH-Measurements-web.pdf>

9.3.4. Dissolved Oxygen

Dissolved oxygen content in water is measured using an optical sensor. The DO probe must be calibrated using the calibration cup provided with the sonde or using a wet, white towel wrapped around the sensor guard. Calibration of the DO probe requires that the sonde has information on the current barometric pressure. The 650 display has an internal barometer and automatically provides this during the calibration procedure. Important: when the sonde has been installed in the field, do not clean the probe before performing this initial error check. This allows for determination of sensor drift since the last error check.

Error checking, cleaning, and calibration:

1. Triple rinse all of the probes on the sonde with deionized or distilled or tap water. Shake off excess water or dab lightly with a towel.
2. Take the sonde out of Run mode. Place approximately 3 mm of water in the calibration cup. Only engage the cup threads one turn to ensure the DO probe is vented to the atmosphere. Alternatively, use a wet towel wrapped around the sensor guard in place of the calibration cup. Do not allow water to touch the DO membrane or temperature sensor and ensure the sonde is not in direct sunlight. Allow the sonde to sit at least 10 minutes prior to proceeding so the air around the DO membrane becomes saturated with water vapor.
3. Note the temperature and barometric pressure on the site visit worksheet. Use the DO calculator worksheet or refer to the DO saturation table to find the approximate expected DO level (based on pressure and temperature).
4. Select Sonde Run, and wait for the DO reading to stabilize.
5. Record the dissolved oxygen in mg/l and % under “sonde reading before cleaning and calibration”. The dissolved oxygen value should be within 0.5 mg/l of the calculated saturation value. If it is, the dissolved oxygen sensor check is complete. You may clean any obvious buildup on the sensor at this time. If the reading was not acceptable, clean the sensor according to the directions below.
6. Probe cleaning instructions: The optical DO probe is equipped with a wiper that can be activated manually or automatically (using the 650) to clean the sensor lens. The wiper sponge will need to be replaced periodically (see YSI User Manual), but this should not be necessary to do more than once a year, and it is preferable to leave it to the factory to do this as part of the annual servicing between field seasons. If the wiper is not adequately cleaning the sensor, the best method of cleaning the membrane is just to GENTLY wipe away any fouling with a piece of lens cleaning tissue which has been moistened with water only. Under NO circumstances should one use organic solvents (including alcohol) to clean the sensor membrane.

7. Repeat steps 1–5, entering the new reading under “sonde reading following cleaning”.
8. If the results are still not within 0.5 mg/l, the sensor should be recalibrated, as instructed below.
9. Calibration instructions
 - a. With the probes still in calibration cups (with 3mm of water and threads engaged only one turn to ensure ventilation), select Sonde Menu / Calibrate / Optic T-Dissolved Oxy. Then, select ODOsat% and then 1-Point. Note: Calibration of dissolved oxygen by the DO% procedure also results in the calibration of the DO mg/l mode and vice versa.
 - b. Enter the current barometric pressure in mm of Hg. The correct pressure will often be provided but cross-check with the reading provided in the lower right hand corner of the sonde display.
 - c. Press Enter and wait for the DO% reading to equilibrate. The current values of all enabled sensors will be shown on the screen and change with time as they stabilize. Observe the readings under ODO%.
 - d. When the ODO% readings show no significant change for approximately 30 seconds, press Enter. The screen will indicate that the calibration has been accepted and prompt you to press Enter again to return to the Calibrate menu.
 - e. Select Sonde Run, and wait for the DO reading to stabilize. Record the value under “sonde reading following calibration.” If the reading is within 0.5 mg/l of the calculated value, the DO sensor is properly calibrated.
10. If the post-calibration reading was not satisfactory (within 0.5 mg/l of the calculated value), then recalibrate the probe. If repeated calibration does not result in satisfactory performance, the sensor membrane may need replacement. Contact the Project Leader to determine next steps. If the DO probe is not reading properly, but the other probes work well, you may reinstall the sonde in the field until a replacement sensor is ready to install.

9.3.5. Turbidity (Taiya River only)

The turbidity reading is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference solutions. Keeping the lens covering on the detection unit clean during calibration and field use is critical. The turbidity probe includes an automated optic wiper. This wiper can be activated using the sonde display.

The turbidity calibration solution comes in small quantities and is fairly expensive. Therefore, rather than filling the entire calibration cup (immersing all sensors) with turbidity solution, immerse only the turbidity probe (still attached to the sonde).

Important: when the sonde has been installed in the field, do not clean the probe before performing this initial error check. This check allows for determination of sensor drift since the last error check. The Project and Park Leads should also be aware of the turbidity standard that is specific to the YSI 6136 turbidity probe: the turbidity standard sold by YSI (item 6073G) reads 126 NTU for the 6136 probe (used on SEAN sondes), and 100 NTU on the 6026 probe. Currently, this standard must be purchased for accurate readings. Other brands and materials may not work properly.

Error checking, cleaning, and calibration:

1. Triple rinse all of the probes on the sonde with deionized or distilled water. Shake off excess water.
2. Fill the calibration cup with enough distilled water (acting as 0 NTU reference standard) to submerge the turbidity probe, and insert the probe.
3. From display/logger main menu, select Sonde Run.
4. Allow the measurement to equilibrate, then write down the result on log sheet under “Sonde Reading prior to cleaning and recalibration” for the 0 NTU solution.
5. Clean the probe with deionized or distilled water and shake off excess water or dab lightly with a towel.
6. Repeat step 2, but with the 126 NTU reference standard solution, wait for the measurement to stabilize, and record the result.
7. Readings of calibration solutions should fall between 0.0-0.5 NTU for the 0 NTU standard, and between 119-133 NTU for the 126 NTU standard. If they do, the sonde is ready to be reinstalled and you may clean any obvious buildup from the sensor at this time. If the readings fail to meet these criteria, clean the sensor according to the directions below:
8. Probe cleaning: The optical turbidity probe is equipped with a wiper that can be activated manually or automatically (using the 650) to clean the sensor lens. The wiper sponge will need to be replaced periodically (see under “Troubleshooting” below), but this should not be necessary to do more than once a year, and it is preferable to let the factory do this as part of the annual servicing between field seasons. If the wiper is not adequately cleaning the sensor, the best method of cleaning the membrane is just to GENTLY wipe away any fouling with a piece of lens cleaning tissue which has been moistened with water only. Lint-free cloths can be used to wipe off any fingerprints or smudges from the optics as well.
9. Repeat steps 1–7, entering the new readings under “sonde reading following cleaning”.
10. If the results are still not allowable, the sensor should be recalibrated, as instructed below, in Step 11:
11. Calibration instructions:
 - a. Triple rinse all of the probes with deionized or distilled water. Shake off excess water.
 - b. Place a small amount (approx. 25 mL) of distilled water (acting as 0 NTU reference standard) in the calibration cup, thread the cup onto the sonde, and gently swirl the probe in the solution. Discard the water and repeat this step twice.
 - c. Pour turbidity standard into the calibration cup slowly, ensuring no air is bubbled into the solution. If air bubbles are present, tap the cup until bubbles are removed. Note: It is strongly recommended that the calibration cup provided be used for turbidity calibration. If glassware must be used, install the sensor guard first. Plastic beakers or containers can reflect the infrared light beam of the optical sensor and cause errors.
 - d. From the sonde display, select Sonde Menu / Calibrate / Turbidity / 2-point, and press Enter.

- e. Enter "0.0" as the first calibration standard and press enter. Always calibrate with 0.0 NTU solution first to prevent cross-contamination of higher turbidity solutions.
 - f. Select the "clean optics" option to activate the automated wiper. Once the cleaning process is completed, wait for the turbidity measurement to equilibrate, and press Enter.
 - g. Rinse all the probes with deionized or distilled water. Shake off excess water.
 - h. Place the probe in the 126 NTU standard.
 - i. Press Enter to continue calibration.
 - j. Enter "126.0" as the second calibration standard and press Enter. Again, select the "clean optics" option to activate the automated wiper. Once the cleaning process is completed, wait for the turbidity measurement to equilibrate, and press Enter.
12. Check the sensor by repeating steps 1–6, recording the new values under "sonde reading following calibration." If the results are still not allowable, recalibrate. If problems persist, go to *Troubleshooting*, below.

Troubleshooting:

The 6136 optical turbidity sensor used on the YSI 6920 sondes is equipped with a wiper that cleans biofouling from the optical lens. Ensure that the wiper is parking approximately 180 degrees from the optic lens. It is very important not to turn the wiper manually as this will damage the internal gears and void the probe warranty. If the wiper is not parked approximately 180 degrees from the optic lens, select Sonde Run and select "clean optics." The wiper will turn in each direction and park in the correct position. Occasionally the "clean optics" option may need to be selected two or three times to get the wiper to park correctly.

If a calibration error occurs, there are several possible sources of the problem, including air bubbles on the optical surface, contamination of the standard, or internal malfunction of the probe optical system. Whatever the problem, do not override the calibration error message. With the sonde in the Run mode, remove the sensor guard or calibration cup and place a thumb or finger over the probe optics. A high ($> 1,000$ NTU) reading should be reported if the probe is responding correctly. If no response is reported, the probe must be returned for servicing. If the probe is functioning properly, return the probe to the 0.0 NTU solution (distilled water), activate the wiper, and perform a 2-point calibration. Observe the readings of the 0.0 NTU solution. If a value of >5 NTU is reported, it is possible the 0.0 NTU solution was contaminated from debris on the probe(s) or sensor guard carried over from previous field use. Discard the solution, rinse the sonde, and place in new solution. If the new reading is <5 NTU, proceed to the second calibration point. If not, contact the Project Lead to discuss next steps. If a calibration error occurs on the second point, use a new source of standard and perform calibration again.

Occasionally slightly negative turbidity readings may be experienced in very clear waters, as may be encountered in non-glacial rivers in SEAN. The cause is usually due to one of two sources: contaminated 0.0 NTU turbidity solution (distilled water) or interference from the calibration cup during the 0.0 NTU calibration. Avoid contaminated

turbidity solutions by thoroughly cleaning all probes and the calibration cup prior to turbidity calibration procedures. Interference from the calibration cup may be a result of: 1) using a calibration cup with a gray (rather than black) bottom, 2) using a calibration cup with a black bottom contaminated with impurities, or 3) having the probe too close to the calibration cup bottom. To overcome these problems, use a clean, black cup and only thread the cup one turn onto the sonde to keep the cup as far from the probe as possible. If the sensor needs replacement, contact the Project Leader to determine next steps. Removal of the turbidity probe by the user will void the factory warranty.

9.4 Additional Troubleshooting Procedures

Occasionally, problems are encountered during a calibration and the instrument must be reset to return the instrument to factory settings. This is performed using these steps:

1. Access the desired parameter to reset in the calibrate menu.
2. When prompted to input a number for a standard, hold the Enter key down and press the Escape key. Highlight the “yes” key and press Enter.
3. For additional troubleshooting refer to the YSI User manual or call YSI technical support at 1-800-897-4151 and ask for technical support. Before making decisions to modify equipment or software, it is best to check with the Project Lead before proceeding. It is better to lost one day of data than a several weeks due to an avoidable repair or damages equipment.

10.0 Sonde Storage and Handling

In case the sonde needs to be taken out of active monitoring for maintenance or at the end of the field season, it will need appropriate handling and storage until transported back to the office and/or sent to the Project Leader. In the field, the sonde sensor guard should be unscrewed and replaced with the calibration cup with wetted sponge inside, threaded securely onto the sonde, and the communication cables disconnected. The sonde unit should be packed securely into the supplied carrying case to ensure minimal physical disturbance while hiking or driving back to the office. In the office, all probes should remain connected to their sonde ports but should be carefully cleaned using tap water and gently wiped clean if necessary with a cotton cloth (moistened with water only) and/or soft toothbrush (gentle around the optical sensors!) prior to being placed in the calibration cup for longer term storage and shipping to the manufacturer by the Project Leader for annual servicing.

Although some probes do not require wet storage, all probes may be stored wet. The optical DO sensor **MUST** be stored in water or at least a water-saturated air environment and the pH probe should also be stored in a moist environment. The best way of storing the sonde with all probes attached is by threading it onto the calibration cup that holds a water-soaked sponge (a yellow sponge is included with the instrument but may be replaced with any commercial sponge cut to size). If a sponge is not available and water alone is temporarily used, use tap water (or stream water for short time periods) and not distilled water, as the latter may damage the pH probe with prolonged contact.

Storage for each of the individual probes is as follows. However, as mentioned elsewhere in this protocol, the probes generally should not be removed from the sonde by the user unless s/he is certain of the need for this action. After being deployed in the field, the pins holding the probes to the sondes are easily damaged when trying to unscrew the probes. It is best to let the

manufacturer unscrew the probes during the annual maintenance service so as not to incur damage that may not be covered by the instrument warranty.

- **The temperature/conductivity probe and the optical turbidity probe** require no special storage; they can be stored wet or dry. For their long-term storage, the user may wish to remove the probe from the sonde, replace it with a port plug, and store the probe in dry air to minimize cosmetic degradation of the probe body and to maximize the life of the turbidity wiper.
- **The pH probe** (specifically, the reference electrode junction) may be damaged if stored dry or in distilled or deionized or distilled water. Therefore, make sure that it is always stored in a moist environment (ideally in the sonde storage/ calibration cup with a water-soaked sponge). If the probe is disconnected from the sonde for prolonged storage, it should be stored in the vessel (plastic boot or bottle) the probe was delivered in. The vessel should contain a solution of 2 M potassium chloride. Make sure that the vessel is sealed to prevent evaporation of the storage solution.
- **The optical DO probe** must be stored in a wet environment: either water-saturated air (preferred) or water. If stored while connected to the sonde, the storage/calibration cup covering all the probes should contain a water-soaked sponge that will maintain a water-saturated air environment. If the probe is being stored separately, use the protective plastic cap and enclosed sponge provided with the sensor; simply soak the sponge in water and replace the cap on the probe tip. Inspect the sponge every 30 days to make sure it is still moist. If the sensor membrane is allowed to dry out by exposure to ambient air, it must be rehydrated in order to avoid drift at the start of the next deployment. To do so, place approximately 400 mL of water in a 600 mL beaker or similar glass vessel and heat the water on a hotplate or in an oven so that a consistent temperature of $50\pm 5^{\circ}\text{C}$ is realized. Place the probe tip containing the sensor membrane in the warm water and leave it at that temperature for approximately 24 hours, covering the vessel if possible to avoid evaporation. After rehydration is complete, store the probe in either water or water-saturated air prior to deployment and calibration.

When the sonde is packed for shipment to YSI, additional steps are required as specified in Chapter 9 of the user manual.

11.0 Setting up the Sonde to Begin Automated Monitoring

Once the sonde is cleaned, recalibrated, and otherwise ready to be (re)deployed for automated monitoring, the sonde needs to be programmed (using the 650) to log measurements. Again, detailed instruction on setting up and using the 650 are provided in the operating manual, but the essential instructions are provided below.

Use the **650 Sonde menu** selection to access **Sonde Run/ 2. Unattended sample**. The Unattended sample menu will be displayed. Use the following example to understand the unattended sampling option.

Follow the prompts on the “Unattended sample” screen as described below:

To verify and/or correct the time and date, enter **4-Status** or **5-System** menu from the Main menu. You may enter the correct date and time from either of these submenus.

Select **1-Interval** and enter the desired time between samples (for hourly measurements, use 01:00:00)

Select **2-Start Date** and **3-Start Time** to set the time that data will begin to log to sonde memory. (If you do not make any change to these entries, then the study will automatically begin at the next integral time interval once you have pressed **C-Start logging.**)

Select **4- Duration** and set the length of the study in days. In most cases, you will want to stop the unattended study manually or allow the batteries to be expended. Set the duration to a value longer than the anticipated deployment so that if you cannot retrieve the sonde at the expected time, data will continue to be acquired as long as battery power is present. The protocol calls for checking the sonde every 4 weeks; therefore, set the duration to at least 8 weeks, especially for rivers such as the Taiya that may have prolonged periods of high flow in the summer that will prohibit access to the instrument. It will generally be OK to set the duration to the entire season length.

Select **5-File** and enter the formal name of the file, which is used to record the entire data set throughout the season. The file name is exactly six characters of the form SSYYYY where:

SS=the two character site code as defined in Appendix A of the protocol (as of this writing, IN for Indian River, SA for Salmon River, TA for Taiya)

YYYY=the four character year (e.g., 2010)

Double check that the name entered is correctly. It is not easy to change once set.

Select **6-Site** and enter your site name. This name will appear in the sonde file directory, which will be convenient for distinguishing among files if the instrument is used in multiple locations during the season. The site name, however, does not get saved in the data file and is not available to users.

Check **7-Battery** to make certain that the estimated battery life is suitable for the length of the study that you are about to begin.

Select **B-View Parameters to log** to confirm that the sensor and report setups are configured correctly (done in section 5). In some cases, this screen only identifies the raw parameters that are used in the calculation of the parameters selected in the Report setup. For example, although DO mg/L is selected in the Report setup, it does not appear under **View parameters to log** because it is calculated from DO saturation %, Temperature, and Conductivity. Similarly, specific conductance is calculated from Conductivity and Temperature, and it does not appear although selected in Report setup.

After making these entries, the sonde software will automatically estimate the expected battery life and the time it will take for the sonde memory to be filled. The battery change schedule and sampling frequency have been established so that there should be ample power and memory. If the machine reports a deficiency, remedial action should be taken to resolve the issue.

Press **C-Start logging**, followed by **1-Yes** to confirm, and the screen will change to the “Logging” display. This display shows the next date and time for logging, and the stop date and time for the logging study. Verify they are correct.

The Unattended study will terminate when the duration you specified has expired or the batteries are expended. If you want to terminate sooner, simply select **2-Unattended** sample from the Run menu, then **B-Stop logging**. Select **1-yes** and return to the Unattended setup menu.

Power down and disconnect the 650. Seal the sonde data connection outlet and connect the tether line to sonde. Lower the sonde into the ABS housing to begin (or resume) sampling. Secure the tether to a solid point and be sure to take up slack in the tether line so it does not catch debris floating downstream.

12.0 Off-season Maintenance and Storage

At the end of the season, Park Leads will store and package the sonde and probes according to section 10.0 of this SOP. After the sonde and probes are cleaned and stored in the padded case, pack the contents into a cardboard box for shipping to the SEAN Project Leader. In total, pack the sonde, connected probes, data logger (650), field cable, and any spare YSI parts (probes, maintenance kits, or other hardware). Other remaining field supplies listed in Table SOP 1.1 can be retained at each park. With the SEAN shipment, please include a note listing the remaining volumes of each calibration standard and their expiration dates. List remaining field supplies such as squirt bottles, paper, clipboard, etc. This list will assist the Project Leader ordering process for the next field season. Instead of a note, this list can also be transmitted via email to the Project Leader.

Please pack carefully. If the size of the cardboard box allows contents to move, pad the box to minimize movement. If there are any remaining questions regarding how the sonde and probes should be stored prior to shipping, refer to the YSI user manual.

After receiving each park’s sonde and probes, the Project Leader will note the condition of each park’s equipment and prepare for sending to YSI for annual maintenance. The Project Leader will ensure that sondes are properly decontaminated in 70% isopropyl alcohol or a solution of ¼ cup bleach for every 1 gallon tap water. This decontamination should also occur in the unlikely event that sondes are transferred between watersheds within a season.

Upon receiving sondes and probes from YSI after annual maintenance, The Project Leader will ensure that sondes are stored correctly for long-term storage before the next field season.

Before May 1 each year, the Project Leader will conduct individual on-site training with water quality monitoring staff in each park, ensure that each staff has the necessary equipment to conduct a successful monitoring season, and assist in the initial sonde installation. After initial sonde installation, monthly service and data downloading will be conducted by Park Leads and support staff.

SOP 2: Data Evaluation and Grading

Version 2

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
	March 2013	C. Sergeant	Changes to calibration standard values in accordance with revised SOP 1	2
-	Oct. 2011	C. Sergeant, B. Moynahan	Initial version	1

1.0 Introduction

After raw freshwater water quality data is collected in the field, data are evaluated by the Park and Project Leads for accurate transfer of data from the sonde to the handheld data display to the computer (SOP 3). After this initial evaluation, erroneous values are flagged and remaining data are quality-graded (Poor/Fair/Good/Excellent).

This SOP describes which raw values will be flagged as outliers and prescribes a method for grading the quality of remaining data. Generally, USGS guidelines and standard procedures for water quality monitoring (Wagner et al. 2006) are followed, with some modifications required by logistical constraints.

2.0 Flagging Erroneous Values

Before raw data are graded or processed, erroneous (invalid) values are flagged by the Project Leader based on minimum and maximum acceptable values (Table SOP 2.1). Data outside of these ranges are most likely due to sensor malfunction or readings taken during sonde servicing while the sonde was out of water. All flagged values are reviewed for accuracy and approved by the Project Leader. In addition, the Project Leader identifies other erroneous values that may fall within the acceptable value range, but based on expert opinion are not representative water quality values. For example, while the sonde was being serviced, a single temperature reading of 18°C may have been recorded by the sonde, but the preceding and subsequent values taken from the river were much lower. It was obvious that the higher reading was recording air temperature during a monthly maintenance trip and should be flagged as an outlier. In all cases, data will be examined carefully and properly documented to ensure that potentially important marginal values are not incorrectly flagged as erroneous.

Table SOP 2.1. Minimum and maximum acceptable values for each water quality parameter. Because long-term water quality data sets do not exist for rivers monitored by SEAN, these ranges may be updated over time based on future observations.

Measured Field Parameter	Minimum Acceptable Value	Maximum Acceptable Value
Water temperature	0.0°C	18.0°C
Specific conductance	0 mS/cm	2 mS/cm
Dissolved oxygen	1 mg/L	18 mg/L
pH	5 units	10 units
Turbidity ¹	0 NTU	1,000 NTU

¹ Range based on manufacturer's stated measurement capacity

3.0 Data Grading

Data grading assigns a quality rating to discrete periods of water quality data based on observed fouling error and calibration drift between monthly sonde maintenance visits. We use a data grading procedure slightly modified from strict USGS protocols (Wagner et al. 2006). Our approach avoids the necessity of a field meter during monthly maintenance visits, which would complicate field procedures, increase time requirements for site visits, and add to logistical considerations.

During each monthly maintenance visit (SOP 1), Park Leads will record measured values of each parameter against calibration standards with the exception of temperature, which will be compared to readings from an NIST-traceable thermometer. The observed deviation between the calibration standard value and the measured parameter value will be used to grade data based on the recommended USGS ranges (Table SOP 2.2). Three parameters will be checked against standards: conductivity (1,000 mS/cm), pH (7 and 10), and turbidity (0 and 126 NTU). For parameters calibrated against two standards, deviation from the standard will be averaged.

Table SOP 2.2. Table of data grade ranges for each measured water quality parameter based on the recommendations of Wagner et al. (2006).

Measured Field Parameter	Data Grade Range			
	Excellent	Good	Fair	Poor
Water temperature	$\leq \pm 0.2^{\circ}\text{C}$	$> \pm 0.2\text{--}0.5^{\circ}\text{C}$	$> \pm 0.5\text{--}0.8^{\circ}\text{C}$	$> \pm 0.8^{\circ}\text{C}$
Specific conductance	$\leq \pm 3\%$	$> \pm 3\text{--}10\%$	$> \pm 10\text{--}15\%$	$> \pm 15\%$
Dissolved oxygen	$\leq \pm 0.3\text{ mg/L}$ or $\leq \pm 5\%$, whichever is greater	$> \pm 0.3\text{--}0.5\text{ mg/L}$ or $> \pm 5\text{--}10\%$, whichever is greater	$> \pm 0.5\text{--}0.8\text{ mg/L}$ or $> \pm 10\text{--}15\%$, whichever is greater	$> \pm 0.8\text{ mg/L}$ or $> \pm 15\%$, whichever is greater
pH	$\leq \pm 0.2$ units	$> \pm 0.2\text{--}0.5$ units	$> \pm 0.5\text{--}0.8$ units	$> \pm 0.8$ units
Turbidity	$\leq \pm 5\%$	$> \pm 5\text{--}10\%$	$> \pm 10\text{--}15\%$	$> \pm 15\%$

4.0 Literature Cited

Wagner, R.J., R. W. Boulger, Jr., C. J. Oblinger, and B. A. Smith. 2006. Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3. 51 pp. + 8 attachments. Available at <http://pubs.water.usgs.gov/tm1d3> (accessed March 2013).

SOP 3: Uploading and Delivering Monthly Sonde Output Data

Version 2

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
	March 2013	Chris Sergeant	Menu options updated to reflect both EcoWatch and EcoWatch Lite	2
-	June 2010	Bill Johnson	Initial version	1

1.0 Summary

The YSI-650 MDS (“650”) device is connected to the sonde in the field. The season’s cumulative seasonal data are copied from the sonde to a file on the 650. Back in the office, the 650 file is copied to a local drive using YSI’s EcoWatch or EcoWatch Lite software. That copied file is then renamed and written to a network drive where it is guaranteed to be backed up. That file and related information are then submitted to the Project Leader using an email message with a prescribed format. The deliverable item ultimately produced from the data files is called FQ_E and includes the raw data downloaded from each sonde during the monitoring season. Once certified, these data are submitted to SEAN’s online cumulative database, NPS-Water Resources Division’s NPStoret database, and the EPA national water quality database. In addition to the sonde data files, the email submission also includes the site visit workbook “xlsx” file that corresponds to the visit. Collectively, the monthly data files and site visit workbooks are the basis for deliverable FQ_C for the season.

Parts of this procedure are sequenced with the field visit tasks detailed in SOP 1.

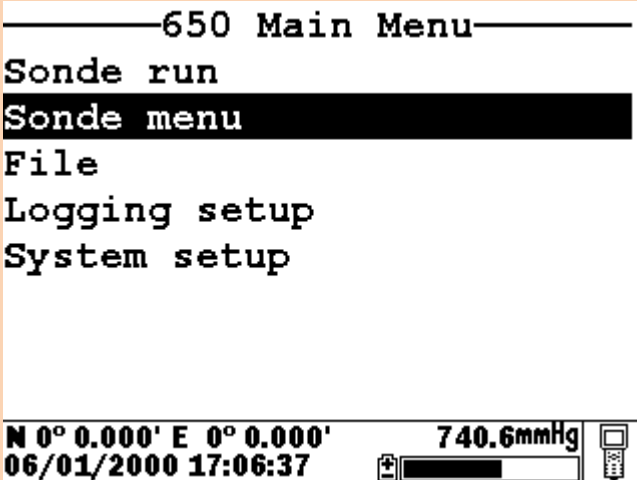
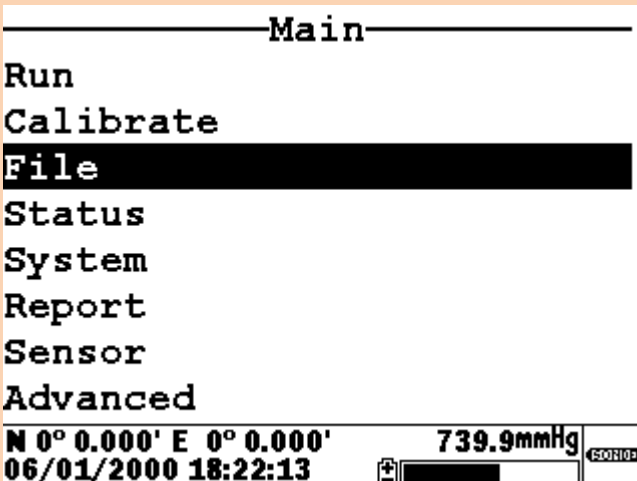
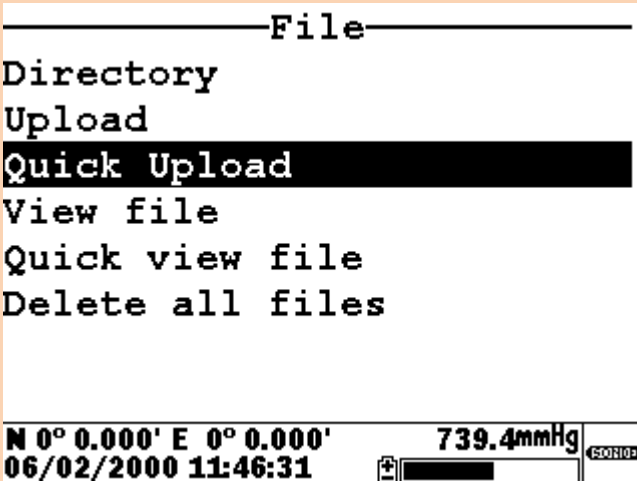
2.0 Connecting the 650 to the Sonde

When the 650 is connected to the sonde, one can configure the sonde for one’s particular application and upload data off the sonde.

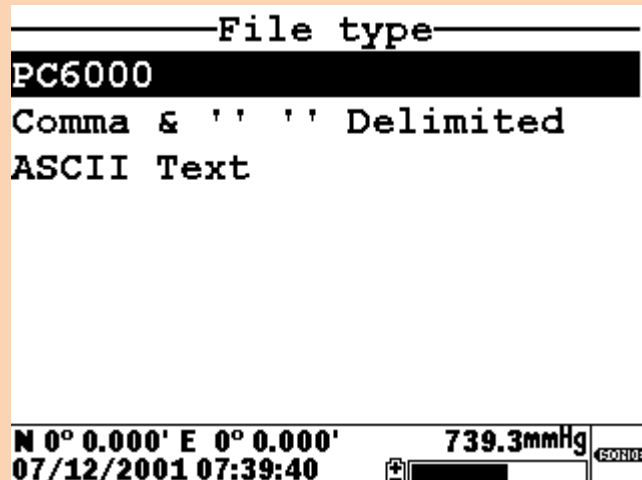
The YSI field cable is used to connect the 650 (from the bottom of its case) to the sonde via the MS-8 connectors. To connect to the 650 to the field cable, rotate the cable connector until engagement occurs, and rotate the field cable connector approximately $\frac{1}{4}$ turn until it is fully engaged with a “click”. To attach the other end of the field cable to the sonde connector, remove the waterproof cap from the sonde connector and set it aside for later reassembly. A built-in “key” will ensure proper pin alignment. Rotate the cable gently until the “key” engages and then tighten the connectors together by rotating clockwise. Be careful not to over tighten or bend the signal pins.

3.0 Uploading Data from the Sonde to the 650

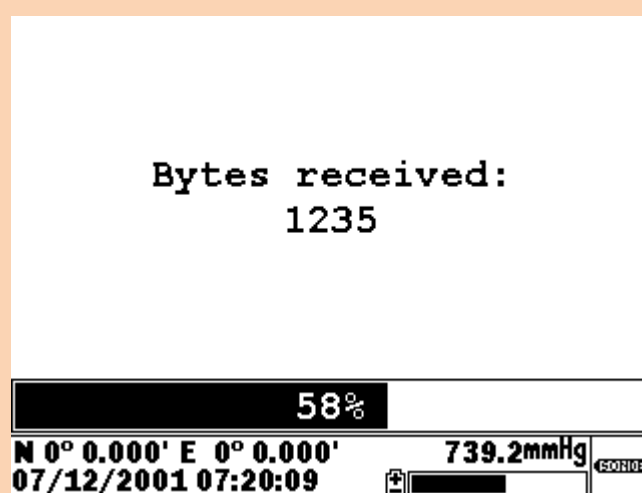
The following steps illustrate how to copy the latest data from the sonde into the 650.

<p>After connecting the sonde to the 650, press the “on” button on the upper left of the 650 keypad. The screen titled “650 Main Menu” will be shown. Press the down arrow to highlight Sonde menu and press Enter.</p>	
<p>Notice the lower right icon is now a sonde symbol on the displayed “Main” screen. Scroll down to highlight File and Enter.</p>	
<p>On the “File” screen choose Quick Upload (Enter) to copy the most recent file. There is only one cumulative file maintained in the sonde throughout the season and this is periodically copied to the 650 for quality review and safekeeping. The filename was set as part of the process used to start up logging in SOP 1.</p>	

On the “File type” screen select the file format as **PC6000**. Press Enter again, and the 650 display will indicate that an upload is in progress. Be aware that there is no need to turn off data logging in order to copy the file; if the sonde takes an hourly reading while out of the water the data points will be later flagged and discarded from the certified data file.

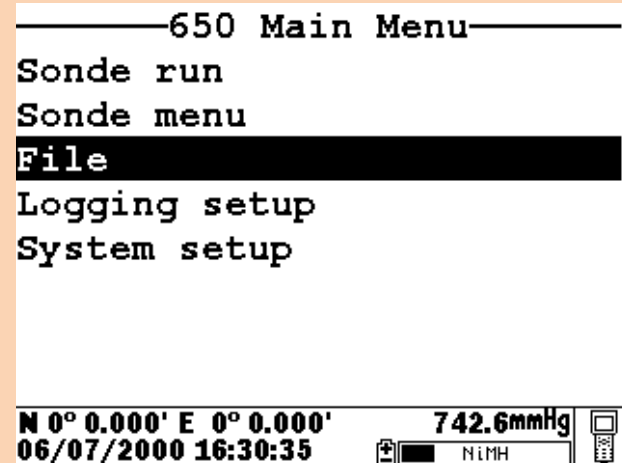


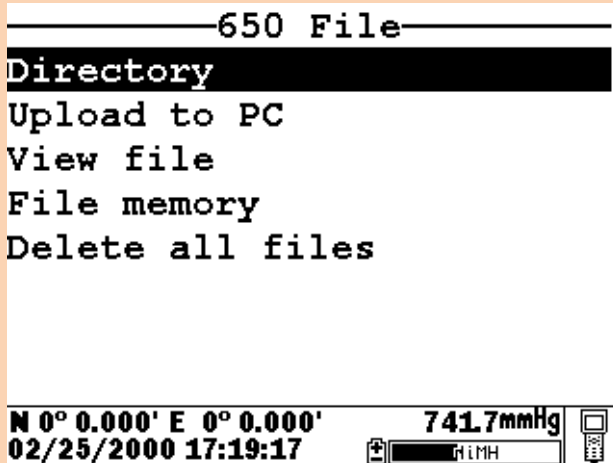
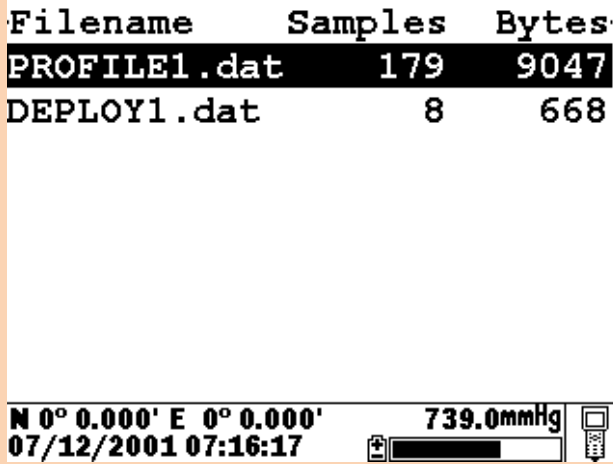
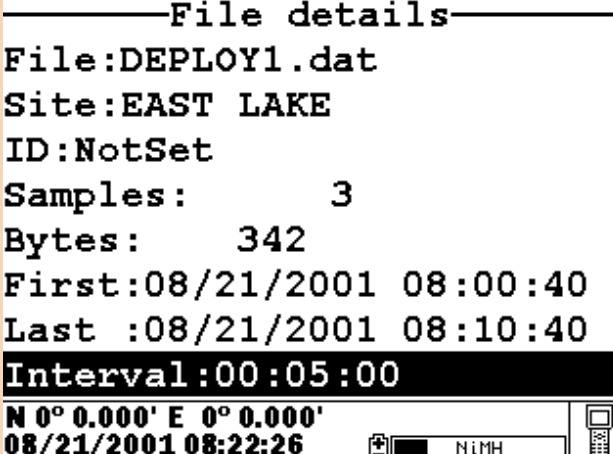
If this is the first upload of the season the file will immediately transfer. The 650 will confirm successful completion by displaying the message “Bytes Received: xxxx.” If this is not the first upload, the 650 warns the file already exists. In this case, select **Overwrite** and press Enter. Only one file is built over the season, though it grows continuously.



It is important to be certain the data file has been correctly copied into the 650 device. The following steps should be taken.

Verify the file is present in the 650 by pressing the Esc button repeatedly to return to the “650 Main Menu.” Select the **File** item (Enter).



<p>On the “650 File” screen select Directory. It should list all the files currently stored in the 650. (Be certain you are <u>not</u> looking at the sonde contents; there should be a 650 icon on the bottom right of the screen).</p>	 <p>650 File</p> <p>Directory</p> <p>Upload to PC</p> <p>View file</p> <p>File memory</p> <p>Delete all files</p> <p>N 0° 0.000' E 0° 0.000' 741.7mmHg 02/25/2000 17:19:17</p>									
<p>Highlight the name of the file just uploaded and press Enter. There is normally only one “.dat” file present.</p> <p>(The files shown here are for illustrative purposes only. They do not follow the required naming convention defined in SOP 1.)</p>	 <table><tr><th>Filename</th><th>Samples</th><th>Bytes</th></tr><tr><td>PROFILE1.dat</td><td>179</td><td>9047</td></tr><tr><td>DEPLOY1.dat</td><td>8</td><td>668</td></tr></table> <p>N 0° 0.000' E 0° 0.000' 739.0mmHg 07/12/2001 07:16:17</p>	Filename	Samples	Bytes	PROFILE1.dat	179	9047	DEPLOY1.dat	8	668
Filename	Samples	Bytes								
PROFILE1.dat	179	9047								
DEPLOY1.dat	8	668								
<p>The “File details” screen should display the starting and ending date of the contents as well as the number of samples recorded. Verify the file details have expected values. Also perform a visual check of the data by scrolling up the “File details” screen and selecting the View File option. Be certain values are being recorded for all columns.</p>	 <p>File details</p> <p>File:DEPLOY1.dat</p> <p>Site:EAST LAKE</p> <p>ID:NotSet</p> <p>Samples: 3</p> <p>Bytes: 342</p> <p>First:08/21/2001 08:00:40</p> <p>Last :08/21/2001 08:10:40</p> <p>Interval:00:05:00</p> <p>N 0° 0.000' E 0° 0.000' 08/21/2001 08:22:26</p>									

After the file transfer is verified the 650 may be turned off. At this point it is typical to perform additional field tasks as indicated in SOP 1. The 650 may be used to perform other functions such as plotting data, but these are outside the standard procedures and not discussed here. However, be aware the other functions may be of use for some purposes, such as problem diagnosis or special research.

4.0 Transferring Data from the 650 to the Office Network Drive

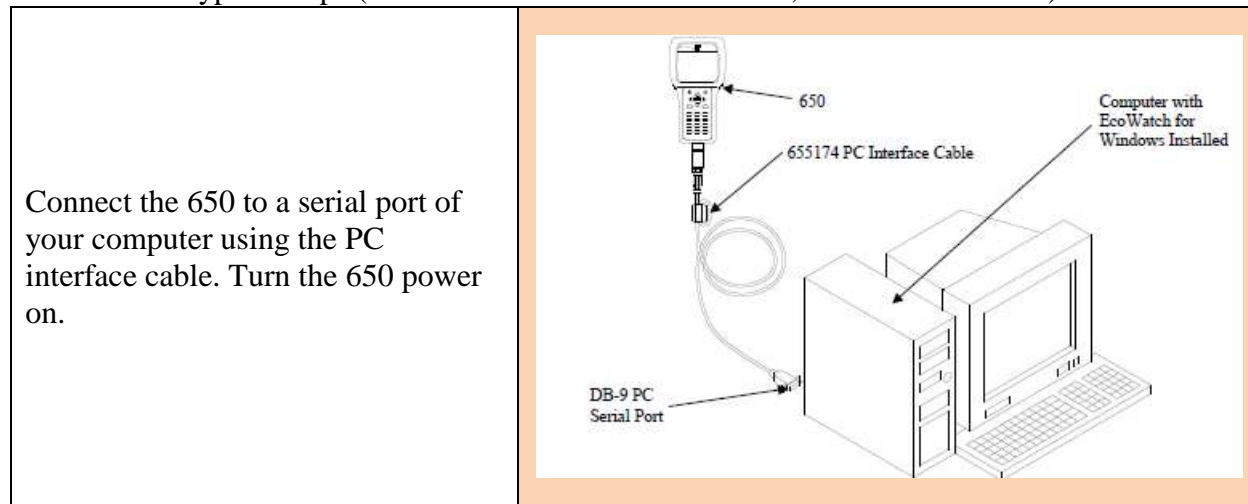
After the 650 is brought back to the office from the field, the data must be transferred to the NPS network—not a local workstation—using YSI’s EcoWatch or EcoWatch Lite software. The NPS network is used because NPS does not reliably back up files on local machines, but does on file servers. **Important:** Note that at the time of this publication, Windows 7 users will be forced to use EcoWatch Lite, as EcoWatch is not supported on this operating system. EcoWatch Lite may be downloaded from the YSI website:

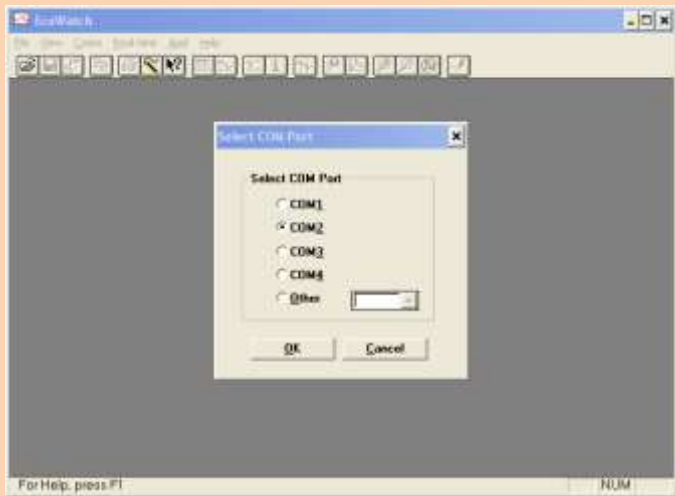
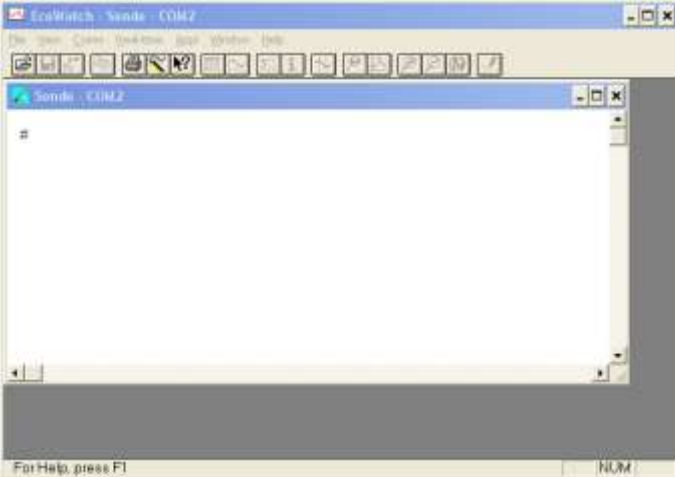
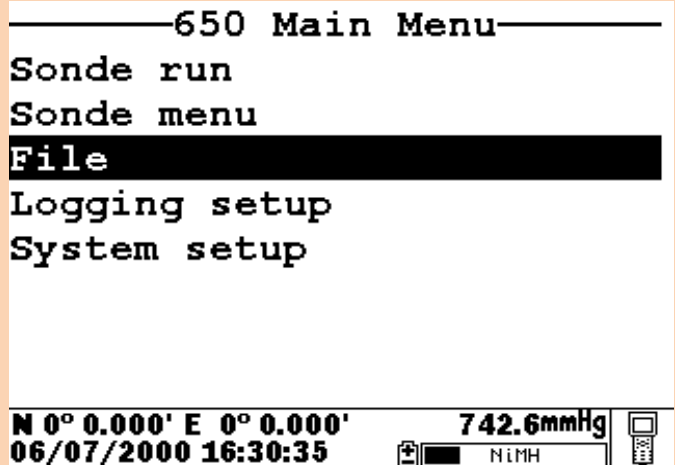
<http://www.ysi.com/software.php>

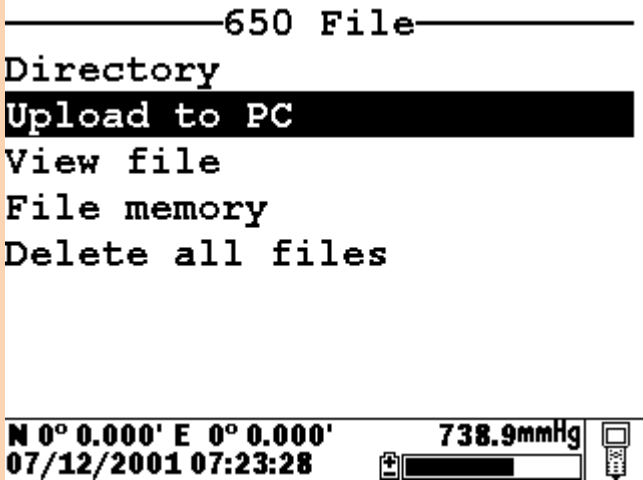
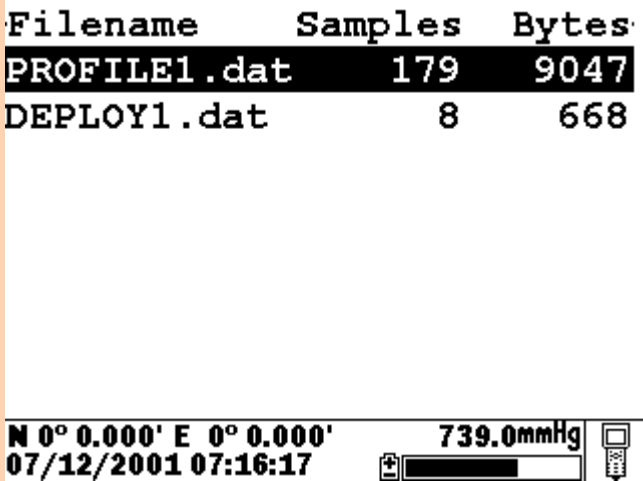
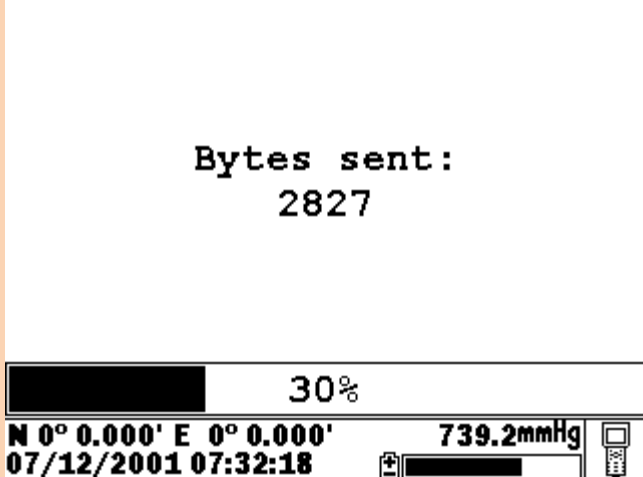
To accomplish data transfer, the following items are required:

1. 650 handheld unit
2. YSI serial interface cable
3. A desktop (or laptop) physically connected to the NPS network and having a 9-pin serial port (USB is not supported by YSI)
4. EcoWatch or EcoWatch Lite software installed on the workstation
5. NPS login credentials permitted to write new files to a place on network file servers, and to create/modify files on the “C:\Program Files\EcoWin” directory on the workstation.

These are the typical steps (screen shots reference EcoWatch, not EcoWatch Lite):

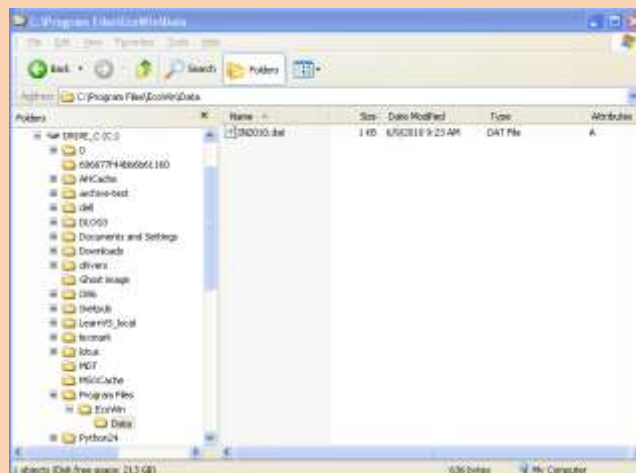


<p>1. Start up the EcoWatch or EcoWatch Lite program on the computer.</p> <p>In EcoWatch, select the menu item COMM SONDE... Click on the “com port” button corresponding to the one the 650 was plugged into and press OK. If you don’t know which port, try each until one is recognized by EcoWatch.</p> <p>In EcoWatch Lite, select File New connection, a blank terminal window will open. Skip to 3.</p>	
<p>2. In EcoWatch, After pressing OK, an empty sonde window should appear inside EcoWatch. If the correct port was used, one or more pound signs (#) should be the only contents in the window. If there is no pound sign, the 650 is not found by the PC – typically due to being powered off or plugged into a different com port.</p>	
<p>3. In EcoWatch and EcoWatch Lite, now turn attention to the powered-on 650. From the startup “650 Main Menu” select File and press Enter.</p>	

<p>4. Select Upload to PC followed by Enter.</p>	
<p>5. Select the .dat file of interest (typically there is only one .dat file present). Press enter and the file contents will be sent to a file on the PC EcoWatch runs on.</p>	
<p>6. The 650 will flash a progress screen showing how many bytes have been sent. Both the 650 and the EcoWatch/EcoWatch Lite screens will announce when the transfer has completed. At that point, the 650 may be powered off, disconnected, and stored. But leave EcoWatch/EcoWatch Lite running for the next step.</p>	

7. In **EcoWatch**, the data file is always stored with the same name as the 650 copy in a directory that also houses the EcoWatch executable software. This is usually at C:\Program Files\EcoWin\Data.

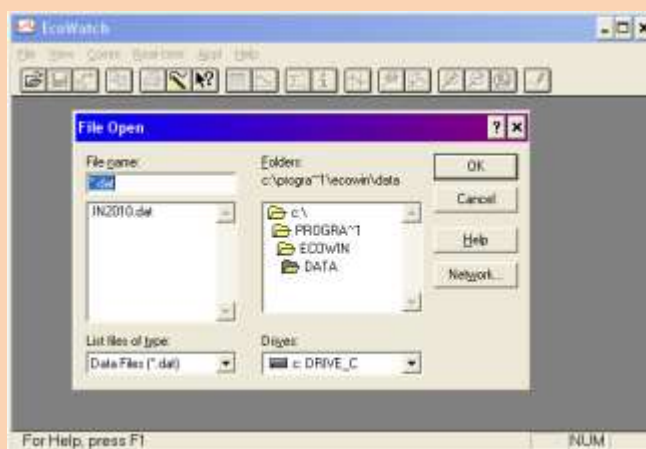
In **EcoWatch Lite**, the file should be stored on the Desktop.



8. Verify the downloaded file is complete.

In **EcoWatch**, select FILE | OPEN... The software uses antiquated file concepts which display truncated directory and file names; awkward but usable with practice. Select the downloaded file and press OK.

In **EcoWatch Lite**, select File | Open and choose the downloaded file from the windows file explorer. It should open to the desktop, where the file is saved by default.

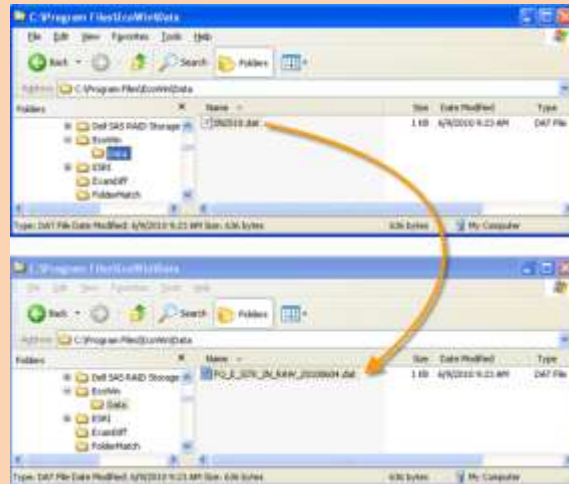


9. **EcoWatch** displays the content as a graph and table. (If the table does not appear by default, press the button as illustrated on the right.) Scroll to the end of the table and verify the last date and time are consistent with when the data was copied from the sonde in the field. If the data rows end significantly before the field site visit, or if the plots display flat lines or no lines, consult with the Project Leader on possible remedial actions. Otherwise, close the EcoWatch program.

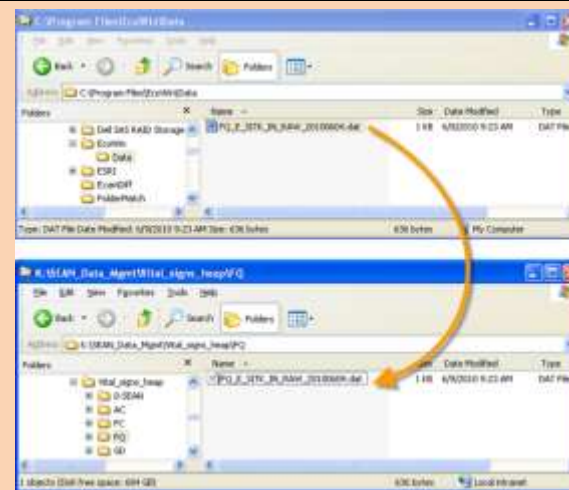
In **EcoWatch Lite**, there is no graphing option, only a table. Scroll to the end of the table and verify the last date and time are consistent with when the data was copied from the sonde in the field.



10. Using Windows Explorer, rename this file to distinguish it from others acquired during the season. Use the form “FQ_E_4-letter park code_2-letter site code_RAW_8-digit date.dat”. The 8-digit date reflects the site visit date as YYYYMMDD. For example:
FQ_E_SITK_IN_RAW_20100604.dat

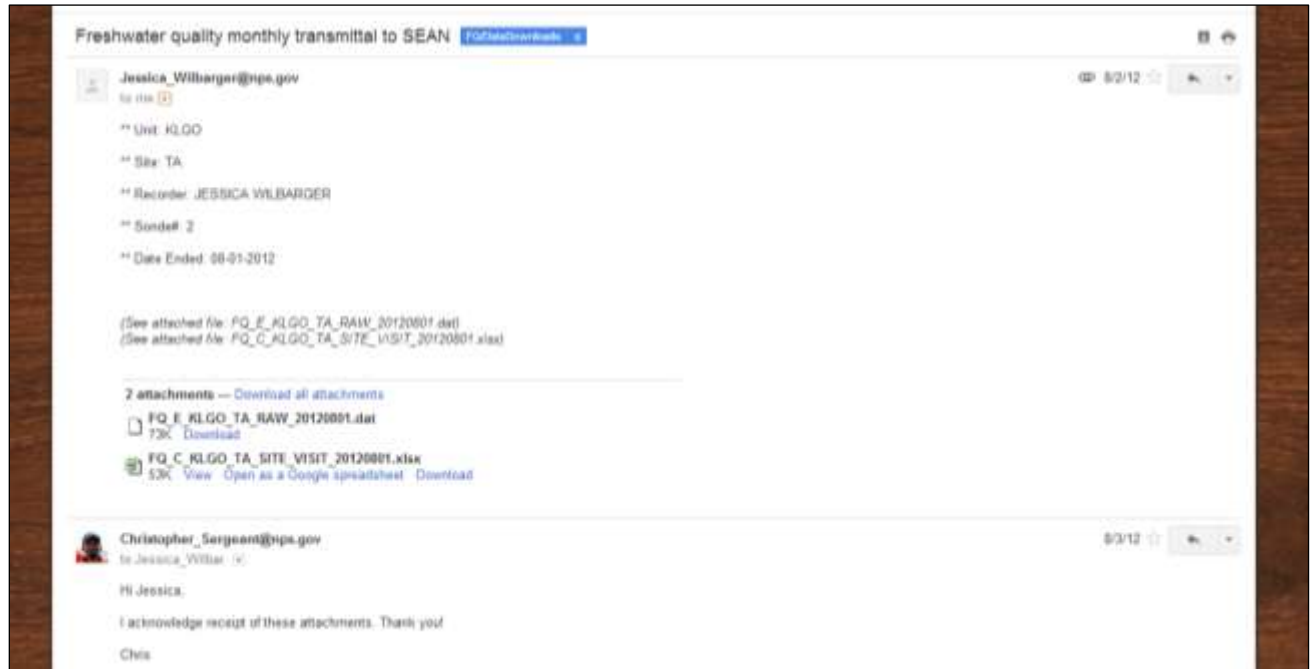


11. Copy the file from the EcoWin directory (or Desktop) to an appropriate area on your network file server. This assures the data will be backed up and kept available to others. Since every park has considerably different server organization, it is up to the Park Lead to determine the best location for .dat files.



5.0 Transmitting the Data File to the Project Leader

The data file must be sent electronically to the Project Leader following each monthly data download. The form is an email with specific text and the .dat file attached, as illustrated below. The Site Visit Workbook from SOP 1 should also be available at this point, and that sheet should be attached to this message.



- The addressee should be the Freshwater Water Quality Project Leader, currently: christopher_sergeant@nps.gov
- It helps the Data Manager if the subject line in the example is used, with proper site and date substituted.
- The five first lines in blue are required. Note that these lines must begin with two asterisks and a space.
 - ** Unit:
 - GLBA, KLGO, or SITK
 - ** Site:
 - IN for Indian River, SA for Salmon River, or TA for Taiya River
 - ** Recorder:
 - First and last name of the individual who downloaded and is transmitting the data file
 - ** Sonde#:
 - 1 (presently deployed in GLBA), 2 (KLGO) , or 3 (SITK)
 - ** Date Ended:
 - Date of last record in this data file, in MM-DD-YYYY format.

It is very helpful that spelling and punctuation for these prescribed strings be exact, as their content will used examined by a machine to assign values to certain fields in the final database. Once the proper form is created by Park Leads in a message, it might be

helpful to just cut and paste that text in subsequent transmittal emails. Most of the values are static.

- Additional lines may be added to the email text beginning with “** ”. Any such lines present will be considered comments and will be appended to the database COMMENTS column.
- Only one .dat and one .xlsx file should be attached, as the narrative header can apply only to data from one specific visit.

As soon as practical after the message is received the Project Leader will acknowledge receipt with an email reply. The leader stores the attached files in \\INPGLBAFS03\DATA\SEAN_Data\Work_Zone\FQ\yyyy\xx\yyyy-mm-dd\, where yyyy is the calendar year of study, xx represents the first two letters of the subject river and yyyy-mm-dd is the date of the site visit. The text of the email message is also saved in that folder under the name “MailText.txt”. The Project Leader then opens the data file using EcoWatch and examines the graph. If any sensors appear to be failing, the Project Leader works with the Park Lead to affect repairs.

The Project Leader reviews the site visit workbook using Excel. Any errors, omissions, or suspect calibration readings are noted for further work.

If there is a technical problem with the transmission or contents, the Project Leader will resolve it with the Park Lead while the visit is still fresh in everyone’s mind.

If this is the first data submission from any site for the year, notify the Data Manager. The Data Manager records the first site visit date on the deliverable tracking spreadsheet for the year.

6.0 File Retention

All files in the 650 are retained for the season: nothing is deleted. After the season ends and the FQ_E deliverable is certified, both the sondes and the 650s must have their memories wiped clean.

SOP 4: Protocol Revision (FQ_A Creation)

Version 1

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
-	Aug 2011	Chris Sergeant	Initial version	1

1.0 Summary

The freshwater water quality monitoring protocol (Deliverable FQ_A) may be revised as new knowledge, technology, and methods become available. Revisions will balance the advantages of new techniques with the possible disadvantage of disrupting data continuity. Changes may also be made to correct significant errors in the document or to refine and update the data reports. Every effort will be made to ensure that complete, certified protocol revisions are applied before the start of a new continuous monitoring period on May 1. Exceptions to this deadline include revisions that would remedy identified safety deficiencies, significant data quality issues, or continuity of operations.

All revisions will require a review for clarity and technical soundness. Small changes to the existing protocol documents—for example, formatting, simple clarifications of existing content, small changes in the task schedule or project budget, or general updates to information management handling—may be reviewed internally by project cooperators and SEAN staff. Changes to data collection, analysis techniques, or sampling design may trigger peer review depending upon the significance of the changes. Formal external peer reviews will be coordinated by the Alaska Region Inventory and Monitoring Coordinator.

The SEAN Program Manager will periodically poll the Project Leader and Data Manager on the need to initiate a protocol revision cycle. If initiated, the process will be cooperatively managed by the Project Leader, SEAN Program Manager, and SEAN Data Manager. During a revision cycle, proposed revisions may originate from any of those three individuals. One of these three people, typically the Project Leader, shall agree to be “Revision Coordinator” and take responsibility for drafting the document. Proposed contributions and internally tracked-changes will be resolved by the Revision Coordinator until consensus is reached on a final draft document. If an external peer review is required, the coordinator will resolve external comments in consultation with the other two internal participants.

A revised protocol must be given a new protocol identifier, using the form detailed in the SEAN data management plan (Johnson and Moynahan 2008). The new protocol will be disseminated and archived through standard SEAN practices and will be submitted to appropriate NPS repositories outside SEAN.

2.0 Detailed Chronological Steps

1. Program Manager (PM)

1. *Periodically poll Project Leader (PL) and Data Manager (DM) on the need for a protocol revision cycle*
2. *Schedule a revision cycle when called for by consensus*
3. *Obtain a new formal protocol ID number from DM*
 1. Method for assigning a protocol ID is formally set in SEAN's Data Management Plan SOP-602 Version Control (Johnson and Moynahan 2008)
 2. A new ID is required for each revision because most data collected are tagged with the specific protocol under which they were created
4. *Solicit agenda of issues to address*
5. *Initiate kick-off meeting*

2. Program Manager, Project Leader, and Data Manager Tasks

1. *Prepare issues lists*
2. *Agree on overall scope of revision*
 1. "Minor" will have internal review
 2. "Major" will have internal and peer review
3. *Agree on a "Review Coordinator" who is responsible for managing assembly of the revised document*
4. *Obtain the most recent Word version of the current protocol from the DM to serve as the basis for the new document*
 1. The original DOCX file is copied to an editable destination file
 2. The document is set for Track Changes
 1. A global search and replace is done to change all existing references to the protocol ID to the new designator
 2. The DM provides a link allowing access to the DOCX file by the three team members through a browser
 3. The actual final product will be made available on the web as only a read-only PDF in order to minimize the change of multiple conflicting documents being built
5. *Draft possible revisions*
 1. Each team member should take responsibility for sections within their realm of expertise
 2. If a particular section needs to be addressed by multiple disciplines, it should be edited in sequence
 3. Agree on editing sequence
 4. Assign first editor
 5. Obtain consensus on the first revision
 6. Assign second editor, and so forth

3. Review Coordinator Tasks

1. *Assemble revisions into a coherent document*
2. *Maintain a document change table in the SOP document to track internal versioning*
3. *Distribute to other internal staff for review*
4. *Update document to satisfy internal review*
5. *Format the document (if available, this may instead be done by an assigned copy editor)*
6. *If scope is major, coordinate an external review*
 1. *Submit document to Alaska Region Inventory and Monitoring Coordinator for consideration*
 2. *Distribute external peer review comments to internal staff*
 3. *Revise protocol in light of review comments*
 4. *Coordinate revisions among internal staff*
7. *Assemble document*
8. *Obtain final internal staff approval*
9. *Format document as a Natural Resource Report (NRR)*
 1. *Coordinate technical and formatting review for NRR*
 2. *Obtain a “TIC” document number from NRSS*
 3. *Make final technical revisions*
10. *Notify team of completion*

4. Program Manager Tasks

1. *Generate a PDF file from the original Word Document*
2. *Submit both the PDF and DOCX files via email attachment to the Data Manager for validation*
 1. *Specify in the message body it is deliverable FQ_A, as defined in protocol FQ-2013.1*

5. Data Manager Tasks

1. *On receipt of the submission, assign the next formal Submission Number to this file, as found in the master Submission_Log table*
 1. *Use the “Update Submission Log” web tool at the data management site:
http://165.83.57.239/0_submission_update.aspx*
 2. *Complete Submission_Log details up through the Submission_Date column*
2. *Save the attached file into the staging area for validation at:
\\npglbafs03\data\SEAN_Data\Staging\FQ\FQ_A\nnnn where “nnnn” is the assigned submission number*
3. *Validate the two files according to current criteria*
4. *Record validation summary data in the Submission_Log using the web tool*
5. *If submission fails mandatory criteria, reply with a “failure email” that includes:*
 1. *The submission number assigned*
 2. *The deliverable ID*
 3. *The protocol ID*
 4. *Documentation listing all the specific mandatory criteria failed*

6. *If submission passes mandatory criteria, reply with a “success email” that includes:*
 1. The submission number assigned
 2. The deliverable ID
 3. The protocol ID
 4. Documentation listing any specific optional criteria failed
 5. Request to certify deliverable as complete

6. Program Manager Tasks

1. *On receipt of a failure email:*
 1. Make corrections so the deliverable meets mandatory criteria
 2. Make another submission with corrected deliverable candidate
2. *On receipt of a success email, review any failed optional criteria:*
 1. If there are acceptable to PM, PL, and DM:
 1. *Reply with a “certification email” stating the deliverable is certified and may be disseminated*
 2. If these are unacceptable:
 1. *Reply with a “withdrawal email,” stating the deliverable is withdrawn*
 2. *Take remedial action to obtain a corrected deliverable*
 3. *Restart the process from the beginning*

7. Data Manager Tasks

1. *On receipt of a withdrawal email:*
 1. Mark the withdrawal in the Submission_Log’s Status column using the web tool
 2. Terminate the process
2. *On receipt of a certification email:*
 1. Due to the nature of these data, NO sensitive information is in the deliverable
 2. Copy the two submitted files to test environment at:
\\inpglbafs03\data\SEAN_Data_Mgmt\Web_Sites\SEAN-Test\AuxRep\FQ\FQ_A
 1. *Name them <protocol_ID>PDF and <protocol_ID>DOCX*
 3. Create web page link to the new PDF, but not the DOCX
 4. Retire the old protocol so it becomes accessible from the Historical Protocol Link
 5. Mark the certification in the Status column in Submission_Log using the web tool
 6. Propagate from test to production environment
 7. Update the annual deliverable tracking spreadsheet showing date of completion for FQ_A
 1. *Record in the tracking spreadsheet for the year reflected in the Protocol_ID, which may not be the current year*
 2. *An entirely new row will need to be added to the sheet, as this is not a scheduled deliverable already accounted for*
3. *Submit the final document to NPS IRMA Data Store*
4. *Update the Inventory and Monitoring protocol database to reference the new protocol*

5. *Revise web sites to accommodate any altered information structure set in the new protocol*
6. *Update the scope of the formal metadata so it includes the new date and versioning information*

3.0 Literature Cited

Johnson, W. F., and B. J. Moynahan. 2008, Data management plan: Southeast Alaska network. Natural Resource Report NPS/SEAN/NRR—2008/058. National Park Service, Fort Collins, Colorado.

SOP 5: Data Availability (FQ_B Creation)

Version 1

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
-	Aug 2011	Bill Johnson	Initial version	1

1.0 Summary

Once the FQ_F database update has been certified for the year, the presence of data by parameter and location must be publicly documented in FQ_B. The Data Manager retrieves the most recent FQ_B version as an Excel spreadsheet. A database query is executed for the year to show by site by month the presence of readings for temperature, conductivity, pH, dissolved oxygen, and turbidity. The spreadsheet is updated to reflect this and saved. A PDF is made of the new spreadsheet. It is installed in the repository for dissemination.

All tasks are performed by the Data Manager.

2.0 Detailed Steps

1. Prepare a new formal submission to hold the generated deliverable.

1. *Use the tool on the data management website to create a new submission. Fill in details through the Submission_Date field).*
2. *Create a subdirectory in the staging area bearing the name of the assigned submission number under \\NPGLBAFS03\DATA\SEAN_Data\Staging\FQ\FQ_B\.*

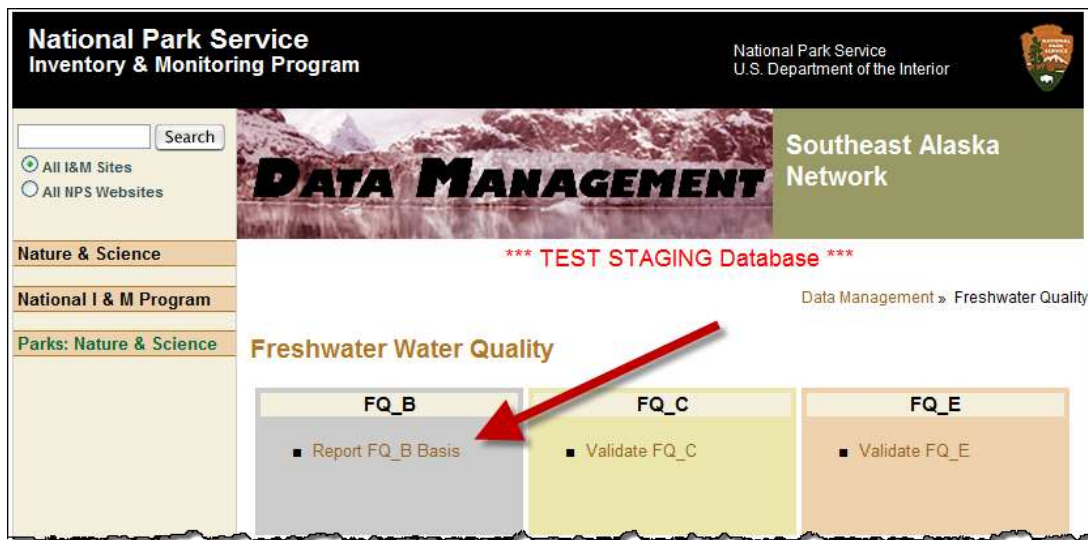


Figure SOP 5.2: Generating the availability report from the FQ_F database from the data management web site.

6. Spot check older sheet cells against the comprehensive database query.

1. If the query results do not appear consistent with the existing spreadsheet, investigate cause to determine whether it is the result of normal operations or of an error that requires correction.
2. If the result appears caused by a failure that requires remediation, then launch an ad hoc effort to repair damage.
3. Exhaustive comparison is not required because older data are not likely to change.

7. If no unresolvable inconsistencies were detected above, update the sheet to reflect new values in the latest year.

1. Copy around appropriate cell icons in file yyyyymmdd.xlsx so they represent the scope of data reported by the query.
2. If this is the first deliverable creation for the latest survey year, additional rows must be added to the underlying sheet and populated. Otherwise overwrite the existing cells of the year with the latest information.

8. Save the new components of FQ_B.

1. Resave the updated yyyyymmdd.xlsx in the staging area.
2. Also save yyyyymmdd.xlsx as a PDF file named current.pdf in the same folder.
3. Be sure the mandatory validation criteria in the data definition appendix are met.
4. Copy both the XLSX and PDF files to the DEVELOPMENT web site at \\NPGLBAFS03\DATA\SEAN_Data\FQ\FQ_B.

- 9. Verify the new FQ_B is being properly served by the development web site.**
- 10. Propagate the affected files to integration and then production and verify their accessibility.**
- 11. Update the submission record using the tool on the data management web site. Fill in all fields to indicate certification with no validation errors.**
- 12. Update the deliverable tracking spreadsheet with the date of completion for this FQ_B, and propagate the tracking sheet to the production site.**

SOP 6: Site Visit Worksheets (FQ_C Creation)

Version 1

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
-	Sept 2011	Bill Johnson	Initial version	1

1.0 Summary

At the end of field season, the Project Lead verifies worksheets have been received from each site documenting each monthly maintenance visit. The lead assembles these .xlsx files and zips them into a single file covering the full year, which becomes the FQ_C deliverable. The Project Leader and Data Manager iterate validation cycles until the product is certified. The certified product is made available on the web.

2.0 Detailed Steps

1. Project Leader Tasks

1. *Prepare the season's site visit worksheet files in the site subfolders of \\NPGLBAFS03\DATA\SEAN_Data\Work_Zone\FQ\yyyy\ where "yyyy" is the year of study.*
 1. Verify there are the proper monthly .xlsx files in the subfolders for each site. These were placed there by processes described in SOP 3.
 2. Obtain any missing files from Park Leads if they are available.
 3. Verify the filenames meet the exact specification set in SOP 1. Correct as necessary.
 4. Verify the "Time sonde pulled" and "Time redeployed" reflect time zone GMT-8 (Alaska Daylight Time).
 1. *Only worksheets recorded in November may exhibit the fault of reflecting GMT-9.*
 2. *The value can be confirmed by reviewing a corresponding CDF file from the site; sonde records always use GMT-8 timestamps and data recorded when a sonde has been pulled out of the water will be obvious.*
5. Open each file in Excel and verify the content is indeed the formal site visit worksheet. There must be only one tab in the file containing field data and it must be named "Site visit worksheet".
6. Build the deliverable file.
 1. *Using Windows Explorer, copy each .xlsx file up the folder hierarchy to \\INPGLBAFS03\DATA\SEAN_Data\Work_Zone\FQ\yyyy\FQ_C\. Be sure there are no old or unrelated .xlsx files in that specific directory – they could accidentally be pulled into the deliverable.*
 2. *Use Winzip or similar software to generate a single archive file in ...\\yyyy\FQ_C\ containing all the .xlsx files in that folder.*

3. *Rename the resulting deliverable to FQ_C_yyyy.ZIP, where yyyy is the calendar year represented.*
7. Submit the candidate deliverable for validation by sending a formal email to the Data Manager specifying that FQ_C as defined in protocol FQ-2013.1 is available for review. Also specify which year the data cover.

2. Data Manager Tasks

1. *On receipt of submission email, generate a new submission record using the tool on the data management web site. Fill in the details through the Submission Date field.*
2. *Create a subdirectory bearing the name of the assigned submission number in \\NPGLBAFS03\DATA\SEAN_Data\Staging\FQ\FQ_C.*
3. *Copy into the subdirectory the FQ_C_yyyy.ZIP file from \\NPGLBAFS03\DATA\SEAN_Data\Work_Zone\FQ\yyyy\FQ_1.*
4. *If this is the first submission of FQ_C for the year, update the deliverable tracking spreadsheet with its date.*
5. *Execute the automated validation process on the data management web site. The results will be automatically recorded on the submission log.*
6. *If submission fails mandatory criteria, reply with a “failure email” that includes the submission number assigned, deliverable ID, protocol ID, year covered, and the “findings.htm” file generated during validation which details the file faults.*
7. *If, instead, submission passes all mandatory criteria, reply with a “success email” that includes the submission number assigned, deliverable ID, protocol ID, year covered, the “findings.htm” file generated during validation which will detail option errors, and a request to certify the deliverable as complete.*

3. Project Leader Tasks

1. *On receipt of a failure email:*
 1. Open the underlying site .xlsx files with Excel and apply corrections to resolve the listed mandatory errors.
 2. Consult with the Park Lead if necessary.
 3. Restart the submission process from the beginning.
2. *On receipt of a success email:*
 1. Review any failed optional criteria.
 2. If the optional faults are acceptable, then reply to the Data Manager with a “certification email” stating the deliverable is certified and may be disseminated.
 3. If the faults are unacceptable, then reply with a “withdrawal email” stating the deliverable candidate is to be withdrawn. Then take remedial action to correct the optional faults and restart the submission process from the beginning.

4. Data Manager Tasks

1. *On receipt of a withdrawal email:*
 1. Mark the withdrawal in the Submission_log’s Status column using the tool on the data management web site.
 2. Terminate processing.
2. *On receipt of a certification email:*

1. Verify no sensitive information is in the deliverable. Products containing sensitive information cannot be disseminated. (Sensitivity is unlikely for this deliverable.)
2. If the deliverable is judged as sensitive:
 1. *Copy the submitted file to test environment at AUXREP\FQ\FQ_C\SENSITIVE\.*
 2. *Update the Submission_Log's Status to sensitive.*
 3. *Update the test web site with an entry for this year marked to be sensitive and closed.*
 4. *Propagate from test to production environment.*
 5. *Verify deliverable is NOT accessible from production web site.*
 6. *Update the deliverable tracking spreadsheet with the date of completion for FQ_C.*
3. If the deliverable is judge not to be sensitive:
 1. *Copy the submitted file to test environment at AUXREP\FQ\FQ_C\, verifying it is properly accessible.*
 2. *Propagate from test to production environment.*
 3. *Verify deliverable is accessible from production web site.*
 4. *Mark the certification in the Status column in Submission_Log.*
 5. *Update the deliverable tracking spreadsheet with the dates of completion and dissemination for FQ_C.*
4. Update the scope of the formal metadata so it includes this new date range.

SOP 7: Maintenance Log Images (FQ_D Creation)

Version 1

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
-	Aug 2011	Chris Sergeant, Bill Johnson	Initial version	1

1.0 Summary

The SEAN currently uses the 6920V2-2 multi-parameter water quality sonde manufactured by YSI, Incorporated. Each sonde is accompanied with a pH probe (YSI 6561), dissolved oxygen probe (YSI6150), conductivity/temperature probe (YSI 6560), and in the Taiya River only, a turbidity probe (YSI 6136). After each continuous sampling season, sondes are sent in for annual preventative maintenance and/or repair. Annual maintenance includes o-ring seal changes, firmware updates, leak testing, sensor testing, and power consumption and data download testing. With each serviced sonde, YSI provides hard copies of test results and a certificate of compliance guaranteeing that non-user accessed seals will be waterproof for two years from the date of servicing.

Certificates of compliance and testing results are filed until all are received for the calendar year. They are then organized by sonde, scanned by the Project Leader, copied to the SEAN network drive, renamed following a consistent convention, and run through validation/quality assurance iterations until certified and disseminated.

SOP 7 requires users to work in the internal NPS network under valid Active Directory accounts. Access questions should be directed to the Data Manager.

2.0 Detailed Steps

1. Project Leader Tasks

1. *For each sonde, collect only those forms for the calendar year that pertain to sensor testing results and certificate of compliance for waterproof seals.*
2. *Scan each group of sonde-specific forms for the year into its own single PDF file.*
3. *Rename each file with the sonde serial number, followed by underscore, followed by service year.*
 1. Sonde serial numbers may be found on maintenance forms.
 2. Example filename: 08H100353_2011.PDF.
4. *Copy each PDF to \\npglbafs03\data\\SEAN_Data\Work_Zone\FQ\yyyy\FQ_D\ where yyyy is the year on the certificate, e.g., 2010.*
5. *Submit the candidate deliverable for validation by sending a formal email to the Data Manager specifying that FQ_D as defined in protocol FQ-2013.1 is available for review. Also specify which single year the data cover.*

2. Data Manager Tasks

1. *On receipt of the submission, assign the next formal Submission Number to this file, as found in the master Submission_Log table.*
 1. Use the “Update Submission Log” web tool on the data management web site at http://165.83.57.239/0_submission_update.aspx .
 2. Complete Submission_Log details up through the Submission_Date column.
 3. Set the submission unit to be SondeSerialNumber_YYYY .
2. *Save the file in the staging area for validation*
 1. The staging directory is
\\INPGLBAFS03\DATA\SEAN_Data\Staging\FQ\FQ_D\nnnn\ where “nnnn” is the assigned submission number. At this time, the “nnnn” folder will have to be created.
3. *Validate the submission according to current criteria. Be particularly sure the filename matches the required form listed above.*
4. *Record validation summary data in the Submission_Log.*
 1. Set status code to V if mandatory validation passed.
 2. Set status code to F if mandatory validation failed
5. *If submission fails mandatory criteria, reply with a “failure email” that includes:*
 1. The submission number assigned
 2. The deliverable ID
 3. The protocol ID
 4. Documentation listing all the specific mandatory criteria failed
6. *If submission passes mandatory criteria, reply with a “success email” that includes:*
 1. The submission number assigned
 2. The deliverable ID
 3. The protocol ID
 4. Documentation listing any specific optional criteria failed
 5. Request to certify deliverable as complete

3. Project Leader Tasks

1. *On receipt of a failure email, ensure that the proper PDF with the correct sonde and probe references were submitted, and restart the submission process from the beginning.*
2. *On receipt of a success email, review any failed optional criteria:*
 1. If these are acceptable:
 1. Reply with a “certification email” stating the deliverable is certified and may be disseminated.
 2. Store maintenance log sheets in an annual paper file kept by the Project Leader.
 2. If these are unacceptable:
 1. Reply with a “withdrawal email”, stating the deliverable is withdrawn.
 2. Take remedial action to obtain a corrected deliverable.
 3. Restart the process from the beginning.

4. Data Manager Tasks

1. *On receipt of a withdrawal email:*
 1. Mark the withdrawal in the Submission_Log's Status column using the web tool.
 2. Terminate the process.
2. *On receipt of a certification email:*
 1. Verify no sensitive information is in the deliverable. Products containing sensitive information cannot be disseminated. (Sensitivity is highly unlikely for this deliverable.)
 2. Copy the submitted file to test environment at AUXREP\FQ\FQ_D\ .
 3. Propagate from test to production environment.
 4. Verify deliverable is accessible from production web site.
 5. Mark the certification in the Status column in Submission_Log using the web tool.
 6. Update the deliverable tracking spreadsheet with the date of completion for FQ_D.
 7. Terminate the process.
3. *Update the scope of the formal metadata so it includes this new date range.*

SOP 8: Sonde Raw Data (FQ_E Creation)

Version 1

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
-	Aug 2011	Bill Johnson	Initial version	1

1. Summary

At the field at end of season, the Project Lead verifies all monthly cumulative data files of type “.dat” made at each site have been received. The lead zips them into a single file covering the full year, which is the FQ_E deliverable. The Project Lead and Data Manager iterate validation cycles until the product is certified. The certified product is made available on the web.

2. Detailed Steps

1. Project Leader tasks

1. *Confirm with Park Leads the sondes have been pulled for the season and that all files have been submitted.*
2. *Locate the season’s .dat sonde output files in the various site subfolders of \\NPGLBAFS03\DATA\SEAN_Data\Work_Zone\FQ\yyyy\, where “yyyy” is the year under study.*
3. *Build the deliverable file.*
 1. Using Windows Explorer, copy each .dat file generated for a site up the folder hierarchy to INPGLBAFS03\DATA\SEAN_Data\Work_Zone\FQ\yyyy\FQ_E\.
 2. Use Winzip or similar software to generate a single archive file in ...\\yyyy\FQ_E\ containing all the .dat files in that folder.
 3. Rename the deliverable to FQ_E_yyyy.ZIP, where yyyy is the calendar year represented.
4. *Submit the candidate deliverable for validation by sending a formal email to the Data Manager specifying that FQ_E as defined in protocol FQ-2013.1 is available for review. Also specify which year the data cover.*

5. Data Manager tasks

1. *On receipt of submission email, generate a new submission record using the tool on the data management web site. Fill in the details through the Submission Date field.*
2. *Create a subdirectory bearing the name of the assigned submission number in \\NPGLBAFS03\DATA\SEAN_Data\Staging\FQ\FQ_E.*
3. *Copy into the subdirectory the FQ_E_yyyy.ZIP file from \\NPGLBAFS03\DATA\SEAN_Data\Work_Zone\FQ\yyyy\FQ_E\.*
4. *If this is the first submission of FQ_E for the year, update the deliverable tracking spreadsheet with its date.*

5. *Manually validate using the YSI EcoWatch application, according to the criteria listed in Appendix D.*
6. *If submission fails mandatory criteria, reply with a “failure email” that includes the submission number assigned, deliverable ID, protocol ID, year covered, and the “findings.htm” file generated during validation which details the file faults.*
7. *If, instead, submission passes all mandatory criteria, reply with a “success email” that includes the submission number assigned, deliverable ID, protocol ID, year covered, the “findings.htm” file generated during validation which will detail option errors, and a request to certify the deliverable as complete.*

6. Project Leader tasks

1. *On receipt of a failure email:*
 1. Open the underlying site CSV files with Excel and apply corrections to resolve the listed mandatory errors.
 2. Consult with the Park Lead if necessary.
 3. Restart the submission process from the beginning.
2. *On receipt of a success email:*
 1. Review any failed optional criteria.
 2. If the optional faults are acceptable, then reply to the Data Manager with a “certification email” stating the deliverable is certified and may be disseminated.
 3. If the faults are unacceptable, then reply with a “withdrawal email” stating the deliverable candidate is to be withdrawn. Then take remedial action to correct the optional faults and restart the submission process from the beginning.

7. Data Manager tasks

1. *On receipt of a withdrawal email:*
 1. Mark the withdrawal in the Submission_log’s Status column using the tool on the data management web site.
 2. Terminate processing.
2. *On receipt of a certification email:*
 1. Verify no sensitive information is in the deliverable. Products containing sensitive information cannot be disseminated. (Sensitivity is unlikely for this deliverable.)
 2. If the deliverable is judged as sensitive:
 1. *Copy the submitted file to test environment at AUXREP\FQ\FQ_E\SENSITIVE\.*
 2. *Update the Submission_Log’s Status to sensitive.*
 3. *Update the test web site with an entry for this year marked to be sensitive and closed.*
 4. *Propagate from test to production environment.*
 5. *Verify deliverable is NOT accessible from production web site.*
 6. *Update the deliverable tracking spreadsheet with the date of completion for FQ_E.*
 3. If the deliverable is judged to not be sensitive:
 1. *Copy the submitted file to test environment at AUXREP\FQ\FQ_E\, verifying it is properly accessible.*
 2. *Propagate from test to production environment.*
 3. *Verify deliverable is accessible from production web site.*
 4. *Mark the certification in the Status column in Submission_Log.*

5. *Update the deliverable tracking spreadsheet with the dates of completion and dissemination for FQ_E.*
3. *Update the scope of the formal metadata so it includes this new date range.*

SOP 9: Cumulative Database (FQ_F Creation)

Version 2

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
1	March 2013	Bill Johnson	Complete rewrite to properly follow data flow.	2
-	Sept 2011	Bill Johnson	Initial version	1

1.0 Summary

After certification of an FQ_J submission, the Data Manager needs to generate the FQ_F database update. Data in the FQ_J files are loaded into the integration database, deleting anything previously submitted for the stated year. Once that is done successfully, the process is repeated for the production database. Certification is inherited from the underlying FQ_F certification. All work is the responsibility of the Data Manager.

2.0 Detailed Steps

8. Data Manager Tasks

1. *After installation of an FQ_J product in the integration environment, check its “sensitivity” status. If the deliverable is judged to be sensitive, it cannot be added to the database.*
 1. Create a Submission_Log entry for the FQ_E attempt.
 1. Fill out its basic information.
 2. Set its Status to sensitive.
 2. Update the deliverable tracking spreadsheet with the date of completion for FQ_E.
 3. Move the submission log entry and deliverable tracking sheet to production.
 4. Skip over the next section and resume at step “Notify the project leader of the job’s success or failure”, below.
2. *If not sensitive, then generate a new FQ_F database update for the submission unit (i.e., year).*
 1. Be certain the underlying FQ_J’s certification has been properly recorded in the submission log.
 2. Invoke the data management site’s FQ_F function, named “Update database from certified FQ_J”.
 3. From the dropdown box, select the particular certified submission to use.
 4. Press the “Create FQ_F” button.
 5. If this submission unit already is found in the staging database, a warning explaining this will appear. Press the “Overwrite” button to confirm the current content should be discarded in favor of the new FQ_F rows. If unsure about deleting the existing data, use the browser’s “back” button to terminate the installation. Then resolve any issues.

6. The application revalidates the FQ_J against the mandatory quality criteria, just in case a problem has been introduced after its certification. If revalidation fails, FQ_F cannot be generated and any issues in the existing FQ_J should be resolved.
7. If revalidation succeeds, FQ_J content is automatically inserted into the database.
8. The application places a findings report in the FQ_J folder, documenting the operation.
9. The application automatically updates the submission log, creating an entry for the FQ_F deliverable, and setting it to reflect both Certified and Staged.
3. *Notify the project leader of the job's success or failure.*
4. *If successful:*
 1. Propagate data from integration to production environment.
 2. Verify deliverable is accessible from production web site.
 3. Update the deliverable tracking spreadsheet with the dates of completion, staging, and production for FQ_F.
5. *Update the scope of the formal metadata so it includes this new date range.*
6. *Generate a cumulative FQ CSV file from the production web site, install it into IRMA, and update the deliverable tracking sheet.*
7. *Propagate the deliverable tracking spreadsheet to production.*

SOP 10: Annual Report (FQ_G Creation)

Version 2

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
1	March 2013	Bill Johnson, Chris Sergeant	Corrected filename typos, minor text revisions	2
-	September 2011	Chris Sergeant	Initial version	1

1.0 Summary

The annual report briefly introduces the context for freshwater water quality monitoring in SEAN, summarizes field efforts from the reporting year, provides summary figures and tables for the status and trends of core water quality parameters, offers short- and long-term (if applicable) trend interpretation, and discusses future monitoring program considerations. The continuous water quality sampling seasons generally runs May 1 through October 31. Annual reports summarize results of the continuous sampling seasons for all three SEAN parks (GLBA, KLGO, and SITK) and are completed by the Project Leader within three months of the completion of each monitoring season.

2.0 Annual Report Format and Content

The Annual Data Report follows the NPS Natural Resource Technical Report format (<http://www.nature.nps.gov/publications/NRPM/>) and includes:

1. **Executive Summary:** Intended for park superintendents and managers; review program purpose and design; summarize Results and Discussion
2. **Acknowledgements:** Field crew, logistical supporters, document reviewers, etc. should be thanked here
3. **Introduction:** Present the monitoring program context, goals, and objectives
4. **Methods:** Describe study areas, field and analytical techniques, and annual deviations from sampling prescribed in protocols
5. **Results:** Present tables and figures of annual and historical results; summarize long- and short-term trends and anomalous or system-specific observations
6. **Discussion:** Generalize main results in the context of monitoring program objectives, provide interpretation for long- and short-term trends or anomalies, briefly describe expected future sampling, what has gone well and should continue, and present recommendations and future considerations for new monitoring work

3.0 Contents of Results Section

In SEAN, four to five water quality parameters are measured hourly for six months each sampling season, producing thousands of lines of water quality data each year that must be concisely summarized. To achieve this goal and maintain long-term relevance, the results of each annual report are directly linked to the objectives described in the protocol narrative. This section

lists the essential data reporting that must accompany each objective and describes each of these report components in sub-sections. Each year, if the Project Leader discovers additional informative results, reporting can expand beyond the essential analyses listed below. Detailed analyses beyond the scope of this report should be considered for authoring a separate peer-reviewed manuscript. The Project Leader's priority is to promptly publish the annual technical report with the main components below:

- **Objectives 1 and 2:** Track the status and trends of each core water quality parameter; describe the timing and magnitude of seasonal and annual variation of each core water quality parameter; as data accumulates over time, compare short-term variation with observed long-term trends

Report components: annual sampling effort (Table SOP 10.1), water temperature summary (Figure SOP 10.1), monthly temperature means and ranges (Table SOP 10.2), conductivity/DO/pH box plot summaries (Figure SOP 10.2), Taiya River turbidity summary (like Figure SOP 10.1), appendices with complete seasonal time series (see Section 7.0 for R code)

- **Objective 3:** Evaluate whether state and/or federal water quality standards are met or exceeded

Report components: period of record (Table SOP 10.3), comparison of state water quality criteria to measured parameter means and ranges (if no standards were exceeded, no comparison table is required)

Tables are formatted in Excel and inserted into Word documents using Paste Special/Picture (Windows Metafile) commands; figures are produced and formatted in several common software packages (e.g., Excel, SigmaPlot, or R). When possible, results from all three rivers (Salmon, Taiya, and Indian) are consolidated into a single panel.

Code for automating production of seasonal time series appendices is included in Section 7.0.



Most results are summarized in graphical form. Brief narratives summarizing general trends or notable results support tables and figures.

3.1 Sampling Effort Table

A sampling effort table summarizes annual data collection in each river system. The table allows the reader to quickly determine if sampling issues were encountered and a full data set collected.

Table SOP 10.1. Example summary table of annual freshwater water quality sampling effort using 2012 data for the Salmon, Taiya, and Indian rivers. Continuous data is collected from May 1 through October 31 each year (and potentially through November depending on ice conditions and staffing capacity). Darker boxes denote a full month of sonde installation, lighter boxes a partial month. Superscripted numbers can be used to comment on protocol exceptions (e.g., a certain sensor was not working for part of the season). The Methods section provides more detailed explanations for gaps in the seasonal time series.

River	Month								Core parameters collected?
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
Salmon									Y
Taiya									Y
Indian									Y

 Full month
 Partial month

3.2 Core Parameter Time-Series Summaries

Water temperature plays an important role in the physiological and biological processes of stream communities. See section 1.7 of the freshwater water quality protocol narrative for an expanded discussion of the importance of temperature. This parameter is likely to be the most variable and immediately informative of the core water quality parameters. Figures illustrate daily mean values for the current reporting year and historical data set (Figure SOP 10.1), while tables summarize monthly continuous data (Table SOP 10.2).

To publish a daily mean or median value for any field parameter, the following minimum requirements apply (Wagner et al. 2006):

“... on days when less than 100 percent of the discrete time interval data are collected, both the expected daily maximum and minimum values must be present. Reporting daily mean values when less than 100 percent of the unit values are available is based on professional judgment and generally is determined by data trends, knowledge of site characteristics, and the influence of hydrologic events.”

In addition to mean daily temperature fluctuations over seasonal scales, measurements of all the core parameters are expected to demonstrate diel variation during discrete time periods, especially when high UV radiation drives photosynthesis-respiration cycles in the Salmon and Indian rivers. Diel variation in the Taiya River will be more controlled by daytime pulses of glacial melt. To examine these patterns, hourly time-series information is summarized in formatting style similar to figure SOP 10.1. The Project Leader can choose to examine representative diel cycles displayed over shorter time periods (e.g., 3 to 10 days). These snapshots can be contrasted among different systems and seasons (e.g., Taiya River vs. Salmon and Indian rivers on five warm, summer days and five cool, fall days; see Sergeant 2012a, b for

examples). It is expected that the magnitude of within-day fluctuations in core parameter values will be greater during summer days compared to fall.

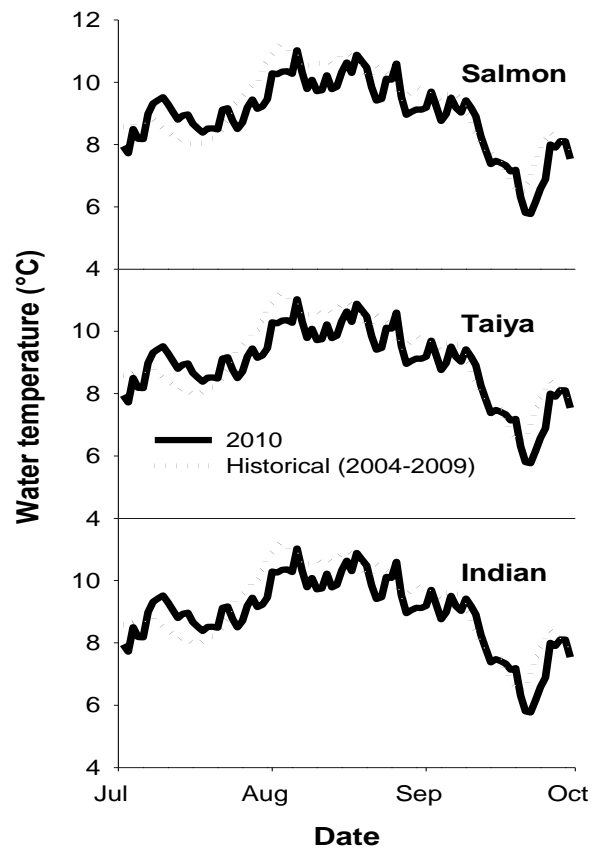


Figure SOP 10.1. Example water temperature summaries for the reporting year versus historical daily mean using artificial data in the Salmon, Taiya, and Indian rivers.

Table SOP 10.2. Example table of monthly mean, minimum daily mean, and maximum daily mean temperatures in the Salmon, Taiya, and Indian rivers.

Month	Salmon			Taiya			Indian		
	Mean daily average (SD)	Min	Max	Mean daily average (SD)	Min	Max	Mean daily average (SD)	Min	Max
May									
June									
July									
August									
September									
October									

3.3 Combined Conductivity, DO, and pH Box Plots

See section 1.7 of the freshwater water quality protocol narrative for an expanded discussion of the environmental importance of conductivity, DO, and pH. Given the expectation that these three parameters will remain relatively static, a time-series graph is not necessarily the most informative data summary. Box plots are the primary visual characterization for the reporting year (Figure SOP 10.2).

However, each season there may be important short-term peaks or valleys in parameter values during discrete time periods due to events such as atypically high flow or acute point source pollution. When these occur, a time-series graph during that time period is displayed following the general format of figure SOP 10.1. Each year, the Project Leader examines time-series graphs of conductivity, DO, and pH for short-duration, high magnitude events that warrant time-series summaries. In addition, R code for generating seasonal time series graphs for each parameter is found in Section 7.0.

3.4 Taiya River Turbidity

Due to strong glacial influence on the hydrologic and chemical characteristics of the Taiya River, turbidity was added as a regularly monitored water quality parameter. Taiya River turbidity is graphed as a single pane in the format of figure SOP 10.1.

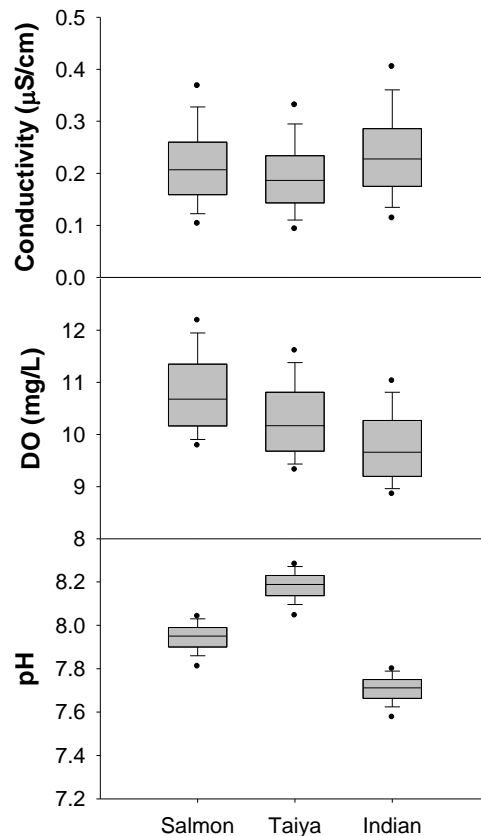


Figure SOP 10.2. Box plots summarizing artificial seasonal measurements for conductivity, dissolved oxygen concentration, and pH in the Salmon, Taiya, and Indian rivers. Horizontal lines within the boxes represent median values, horizontal lines bounding the lower and upper portion of the boxes represent 25th and 75th percentiles, lower and upper whiskers represent 10th and 90th percentiles, and single points represent 5th and 95th percentiles.

3.5 Period of Record and Summary Statistics

A table summarizing the period of record and summary statistics for all data collection will allow readers to quickly determine the breadth of SEAN freshwater water quality data collection efforts and general reference conditions in each monitored river system (Table SOP 10.3).

Table SOP 10.3. Example period of record for artificial freshwater water quality monitoring data collected and reported by SEAN.

River	Parameter	Period of Record	Number of observations	Summary statistics				
				Median	Mean	Standard deviation	Minimum	Maximum
Salmon	Conductivity (µS/cm)	1 January 2004 to 31 December 2011	840	0.207	0.214	0.075	0.055	0.388
	Dissolved Oxygen (mg/L)							
	Dissolved Oxygen (% Sat)							
	pH							
	Temperature (°C)							
Taiya	Conductivity (µS/cm)							
	Dissolved Oxygen (mg/L)							
	Dissolved Oxygen (% Sat)							
	pH							
	Temperature (°C)							
Indian	Conductivity (µS/cm)							
	Dissolved Oxygen (mg/L)							
	Dissolved Oxygen (% Sat)							
	pH							
	Temperature (°C)							
	Turbidity (NTUs)							

3.6 Water Quality Standards

A brief statement is made in the Results narrative on whether state water quality thresholds were exceeded (Table SOP 10.4). If state thresholds are approached or exceeded, a table comparing state standards versus observed parameter values will be displayed.

Table SOP 10.4. Currently, the most stringent Alaska Department of Environmental Conservation (ADEC) water quality standards (ADEC 2011). Superscript numbers denote the category of water quality standard.

Parameter	Criteria
Conductivity	None listed by ADEC
Dissolved oxygen (DO) ¹	DO must be greater than 7 mg/l in waters used by anadromous or resident fish. In no case may DO be less than 5 mg/l to a depth of 20 cm in the interstitial waters of gravel used by anadromous or resident fish for spawning (see note 2). For waters not used by anadromous or resident fish, DO must be greater than or equal to 5 mg/l. In no case may DO be greater than 17 mg/l. The concentration of total dissolved gas may not exceed 110% of saturation at any point of sample collection.
pH ¹	May not be less than 6.5 or greater than 8.5. May not vary more than 0.5 pH unit from natural conditions.
Temperature ^{1,2}	May not exceed 20°C at any time. The following maximum temperatures may not be exceeded, where applicable: Migration routes 15°C Spawning areas 13°C Rearing areas 15°C Egg & fry incubation 13°C For all other waters, the weekly average temperature may not exceed site-specific requirements needed to preserve normal species diversity or to prevent appearance of nuisance organisms.
Turbidity ³	May not exceed 5 NTU above natural conditions when the natural turbidity is 50 NTU or less, and may not have more than 10% increase in turbidity when the natural turbidity is more than 50 NTU, not to exceed a maximum increase of 15 NTU. May not exceed 5 NTU above natural turbidity for all lake waters.

¹ Growth and propagation of fish, shellfish, other aquatic life, and wildlife

² Water supply/aquaculture

³ Water recreation

4.0 Tips for Improving Readability of Results

1. **Monitoring program context:** To retain continuity across annual reports, build the results and narrative in the context of the monitoring program's objectives. Results that may be interesting but are unrelated to program objectives are placed in discrete subsections within the Results section but separate from the main results. If many interesting results occur, or a separate research or monitoring program needs to be discussed in relation to water quality results, an appendix will be added or a peer-review manuscript may be warranted.
2. **Parallel structure:** When listing results in graphs, tables, or narrative, consistently refer to rivers in alphabetical order by park: Salmon (GLBA), Taiya (KLGO), and Indian (SITK). When referring to combined water quality figures, list conductivity, dissolved oxygen, and pH in alphabetical order. Repeating these patterns throughout the annual report will allow the reader to develop a reading pattern and comprehend more quickly.
3. **Black and white:** Use only black and white or grayscale figures. This avoids problems with color-blindness or non-color printers.

5.0 Submission, Validation, and Dissemination of the Deliverable

The final version of FQ_G is reviewed by the SEAN Program Manager and generated as a PDF file by the Project Leader, who delivers it to the Data Manager for the validation checks defined in appendix D of the freshwater water quality monitoring protocol. After the valid report is certified by the Project Leader, the Data Manager installs the final PDF in the auxiliary repository, creates a web link for it, updates the Deliverable Product Tracking grid, and forwards the final FQ_G to the NPS IRMA Data Store.

8. *Program Manager Tasks*

1. Review the final Word report document.
2. Apply any essential corrections.
3. Forward to Project Leader.

9. *Project Leader Tasks*

1. Generate a PDF file from the original Word Document.
2. Submit both the PDF and DOCX files via email attachment to the Data Manager for validation. Specify in the message body it is deliverable FQ_G, as defined in protocol FQ-2013.1.

10. *Data Manager Tasks*

1. On receipt of the submission, assign the next formal Submission Number to this file, as found in the master Submission_Log table.
 1. Use the "Update Submission Log" web tool at the data management site:
http://165.83.57.239/0_submission_update.aspx.
 2. Complete Submission_Log details up through the Submission_Date column.

2. Save the attached files to the staging area for validation at:
\\inpglbafs03\data\SEAN_Data\Staging\FQ\FQ_G\nnnn where “nnnn” is the assigned submission number.
 3. Rename the files to FQ_G_yyyy.PDF and FQ_G_yyyy.DOCX, where “yyyy” is the year covered by the report.
 4. Validate the two files according to current criteria.
 5. Record validation summary data in the Submission_Log using the web tool.
 6. If submission fails mandatory criteria, reply with a “failure email” that includes:
 1. *The submission number assigned.*
 2. *The deliverable ID.*
 3. *The protocol ID.*
 4. *Documentation listing all the specific mandatory criteria failed.*
 7. If submission passes mandatory criteria, reply with a “success email” that includes:
 1. *The submission number assigned.*
 2. *The deliverable ID.*
 3. *The protocol ID.*
 4. *Documentation listing any specific optional criteria failed.*
 5. *Request to certify deliverable as complete.*
11. **Project Leader Tasks**
1. On receipt of a failure email:
 1. *Make corrections so the deliverable meets mandatory criteria.*
 2. *Make another submission with corrected deliverable candidate.*
 2. On receipt of a success email:
 1. *After reviewing any optional criteria violations, if the deliverable is acceptable reply with a “certification email” stating the deliverable is certified and may be disseminated.*
 2. *If it is unacceptable:*
 1. **Reply with a “withdrawal email,” stating the deliverable is withdrawn.**
 2. **Take remedial action to obtain a corrected deliverable.**
 3. **Restart the process from the beginning.**
12. **Data Manager Tasks**
1. On receipt of a withdrawal email:
 1. *Mark the withdrawal in the Submission_Log’s Status column using the web tool.*
 2. *File the email in the Data Manager’s email folder named “SEAN Data Management / FQ”.*
 3. *Terminate the process.*
 2. On receipt of a certification email:
 1. *File the email in the Data Manager’s email folder named “SEAN Data Management / FQ”.*
 2. *Due to the nature of these data, NO sensitive information is in the deliverable.*

3. *Copy the two submitted files to test environment at:*
\\inpglbafs03\data\SEAN_Data_Mgmt\Web_Sites\SEAN-Integration\AuxRep\FQ\FQ_G.
4. *Create web page link to the new PDF, but not the DOCX*
 1. **Mark the certification in the Status column in Submission_Log using the web tool.**
 2. **Propagate from test to production environment.**
 3. **Update the annual deliverable tracking spreadsheet showing date of completion for FQ_G**
5. *Verify that the final document is in the NPS IRMA Data Store and is marked for public access.*

6.0 Literature Cited

- Alaska Department of Environmental Conservation (ADEC). 2012. Water quality standards (18 AAC 70) amended as of April 8, 2012. Alaska Department of Environmental Conservation, Anchorage, Alaska. Available from <http://dec.alaska.gov/commish/regulations/pdfs/18%20AAC%2070.pdf> (accessed March 2013)
- Sergeant, C. J., W. F. Johnson, and B. J. Moynahan. 2012a. Southeast Alaska Network freshwater water quality monitoring program: 2010 annual report. Natural Resource Technical Report NPS/SEAN/NRTR—2012/547. National Park Service, Fort Collins, Colorado. Available from http://science.nature.nps.gov/im/units/sean/FQ_G_Menu.aspx (accessed March 2013)
- Sergeant, C. J., W. F. Johnson, and B. J. Moynahan. 2012b. Southeast Alaska Network freshwater water quality monitoring program: 2011 annual report. Natural Resource Technical Report NPS/SEAN/NRTR—2012/561. National Park Service, Fort Collins, Colorado. Available from http://science.nature.nps.gov/im/units/sean/FQ_G_Menu.aspx (accessed March 2013)
- Wagner, R.J., R. W. Boulger, Jr., C. J. Oblinger, and B. A. Smith. 2006. Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3. 51 pp. + 8 attachments. Available at <http://pubs.water.usgs.gov/tm1d3> (accessed 16 September 2011).

7.0 R code for producing seasonal time series figures

```
#####

# Creating hourly time series data for Appendix A of SEAN FQ annual report

# Script by Chris Sergeant, updated 14 February 2013

# This script reads in data directly from SEAN FQ database, creates NAs for
# parameters with an associated 'record_quality' of 2 or 3 (bad data),
# reformats date & time for graphing in R, subsets data by year and river,
# and exports high-res .png graphics into the specified file that can be
# directly pasted into annual reports. All graphs will have the same x and y
# axes for consistency and easy comparisons between rivers.

#####

#####START USER INPUT#####
#####

## Typically, you will want the date range below to include the entire calendar
## year for the year of interest
## Dates must be inside ' '

start.data = '2012-01-01'
end.data = '2012-12-31'

## Constrain graphing dates by entering preferred date range for x axis
## Dates must be inside "Date"

start.graph = "2012-04-15"
end.graph = "2012-11-20"

## Enter min/max values for y axes of each parameter to keep graphs
## comparable across rivers. Values must be inside c( )

temp.ylim = c(0.01,12.5)
cond.ylim = c(0.01,0.50)
do.ylim = c(6.5,14.4)
ph.ylim = c(6.4,8.2)
turb.ylim = c(0,200)

## Change filepath and filenames for each generated figure below
## Typically, you will only need to change the year at the end of each filepath
## Note that if you change the filepath, R needs a double backslash
## between folders

filepath.in = "U:\\FQ_Misc\\FQ_AppA_Figures\\Indian_2012.png"
filepath.sa = "U:\\FQ_Misc\\FQ_AppA_Figures\\Salmon_2012.png"
filepath.ta = "U:\\FQ_Misc\\FQ_AppA_Figures\\Taiya_2012.png"

#####END USER INPUT#####

## Make sure RODBC package is installed on machine (remove hashtags before
## install.packages if you need to download package):

## install.packages("RODBC")
```

```

## After entering user inputs, select all script (Ctrl-A), then run script (F5)
## Cross your fingers and hope it works!!!

## Read in data from SEAN database:

library(RODBC)
ch2 = odbcDriverConnect('driver={SQL Server};
  server=inpglba27985\\standard;database=sean_staging_2008;
  trusted_connection=true')
#fq = sqlQuery(ch2,"select * from fq.tbl_fq_readings")
fq = sqlQuery(ch2,"SELECT * FROM fq.v_readings_with_delimiter_rows
  ORDER BY park, site, date_local")
odbcClose(ch2)

## Replace parameter values for cells with bad record quality with NA

fq$temperature[fq$temp_record_quality == 2 | fq$temp_record_quality == 3] = NA
fq$conductivity[fq$cond_record_quality == 2 | fq$cond_record_quality == 3] = NA
fq$sph[fq$sph_record_quality == 2 | fq$sph_record_quality == 3] = NA
fq$do_concentration[fq$do_record_quality == 2 | fq$do_record_quality == 3] = NA
fq$turbidity[fq$turb_record_quality == 2 | fq$turb_record_quality == 3] = NA

## Paste date and time columns together

date_time = paste(fq$date_local, fq$time_local)

## Add new date_time column to fq table

fq.new = cbind(fq,date_time)

#####
##### Indian River Appendix #####
#####

fq.indian = subset(fq.new,
  fq.new$site=="IN" &
  as.Date(fq.new$date_time) > start.data &
  as.Date(fq.new$date_time) < end.data)

## Specify filepath and change file name here
png(filepath.in, width=6, height=5,
  units="in", res=250)
par(mfrow=c(2,2),mar=c(2.5,2,1,1))

plot(as.Date(fq.indian$date_time), fq.indian$temperature,
  xlim=c(as.Date(start.graph),as.Date(end.graph)),
  ylim= temp.ylim,
  cex.axis = 0.75,
  xlab="",
  ylab="",
  main="",
  type="l")
mtext("Temperature (°C)", side = 3, line=-1.1, adj = 0.95,
  font = 2, cex = 0.75)

plot(as.Date(fq.indian$date_time), fq.indian$conductivity,
  xlim=c(as.Date(start.graph),as.Date(end.graph)),
  ylim=cond.ylim,
  cex.axis = 0.75,
  xlab="",
  ylab="",
  main="")

```

```

        type="l")
mtext("Specific conductance (mS/cm)", side = 3, line=-1.1, adj = 0.95,
      font = 2, cex = 0.75)

plot(as.Date(fq.indian$date_time), fq.indian$do_concentration,
      xlim=c(as.Date(start.graph),as.Date(end.graph)),
      ylim=do.ylim,
      cex.axis = 0.75,
      xlab="",
      ylab="",
      main="",
      type="l")
mtext("Dissolved oxygen (mg/L)", side = 3, line=-1.1, adj = 0.95,
      font = 2, cex = 0.75)

plot(as.Date(fq.indian$date_time), fq.indian$ph,
      xlim=c(as.Date(start.graph),as.Date(end.graph)),
      ylim=ph.ylim,
      cex.axis = 0.75,
      xlab="",
      ylab="",
      main="",
      type="l")
mtext("pH", side = 3, line=-1.1, adj = 0.95,
      font = 2, cex = 0.75)

dev.off()

#####
#### Salmon River Appendix #####
#####

fq.salmon = subset(fq.new,
  fq.new$site=="SA" &
  as.Date(fq.new$date_time) > start.data &
  as.Date(fq.new$date_time) < end.data)

## Specify filepath and change file name here
png(filepath.sa, width=6, height=5,
     units="in", res=250)
par(mfrow=c(2,2),mar=c(2.5,2,1,1))

plot(as.Date(fq.salmon$date_time), fq.salmon$temperature,
      xlim=c(as.Date(start.graph),as.Date(end.graph)),
      ylim=temp.ylim,
      cex.axis = 0.75,
      xlab="",
      ylab="",
      main="",
      type="l")
mtext("Temperature (°C)", side = 3, line=-1.1, adj = 0.95,
      font = 2, cex = 0.75)

plot(as.Date(fq.salmon$date_time), fq.salmon$conductivity,
      xlim=c(as.Date(start.graph),as.Date(end.graph)),
      ylim=cond.ylim,
      cex.axis = 0.75,
      xlab="",
      ylab="",
      main="",
      type="l")
mtext("Specific conductance (mS/cm)", side = 3, line=-1.1, adj = 0.95,
      font = 2, cex = 0.75)

```

```

plot(as.Date(fq.salmon$date_time), fq.salmon$do_concentration,
     xlim=c(as.Date(start.graph),as.Date(end.graph)),
     ylim=do.ylim,
     cex.axis = 0.75,
     xlab="",
     ylab="",
     main="",
     type="l")
mtext("Dissolved oxygen (mg/L)", side = 3, line=-1.1, adj = 0.95,
      font = 2, cex = 0.75)

plot(as.Date(fq.salmon$date_time), fq.salmon$ph,
     xlim=c(as.Date(start.graph),as.Date(end.graph)),
     ylim=ph.ylim,
     cex.axis = 0.75,
     xlab="",
     ylab="",
     main="",
     type="l")
mtext("pH", side = 3, line=-1.1, adj = 0.95,
      font = 2, cex = 0.75)

dev.off()

#####
#### Taiya River Appendix #####
#####

fq.taiya = subset(fq.new,
                  fq.new$site=="TA" &
                  as.Date(fq.new$date_time) > start.data &
                  as.Date(fq.new$date_time) < end.data)

## Specify filepath and change file name here
png(filepath.ta, width=6, height=5,
     units="in", res=250)
par(mfrow=c(3,2),mar=c(2.5,2,1,1))

plot(as.Date(fq.taiya$date_time), fq.taiya$temperature,
     xlim=c(as.Date(start.graph),as.Date(end.graph)),
     ylim=temp.ylim,
     cex.axis = 0.75,
     xlab="",
     ylab="",
     main="",
     type="l")
#segments(as.Date("2011-07-26"), 5.45, as.Date("2011-09-14"), 5.43,
#         col = "white", lwd = 2)
mtext("Temperature (°C)", side = 3, line=-1.1, adj = 0.95,
      font = 2, cex = 0.75)

plot(as.Date(fq.taiya$date_time), fq.taiya$conductivity,
     xlim=c(as.Date(start.graph),as.Date(end.graph)),
     ylim=cond.ylim,
     cex.axis = 0.75,
     xlab="",
     ylab="",
     main="",
     type="l")
#segments(as.Date("2011-07-26"), 0.02, as.Date("2011-09-14"), 0.031,
#         col = "white", lwd = 2)
mtext("Specific conductance (mS/cm)", side = 3, line=-1.1, adj = 0.95,

```

```

font = 2, cex = 0.75)

plot(as.Date(fq.taiya$date_time), fq.taiya$do_concentration,
     xlim=c(as.Date(start.graph),as.Date(end.graph)),
     ylim=do.ylim,
     cex.axis = 0.75,
     xlab="",
     ylab="",
     main="",
     type="l")
#segments(as.Date("2011-07-26"), 12.61, as.Date("2011-09-14"), 12.46,
#         col = "white", lwd = 2)
mtext("Dissolved oxygen (mg/L)", side = 3, line=-1.1, adj = 0.4,
      font = 2, cex = 0.75)

plot(as.Date(fq.taiya$date_time), fq.taiya$ph,
     xlim=c(as.Date(start.graph),as.Date(end.graph)),
     ylim=ph.ylim,
     cex.axis = 0.75,
     xlab="",
     ylab="",
     main="",
     type="l")
#segments(as.Date("2011-07-26"), 7.26, as.Date("2011-09-14"), 7.47,
#         col = "white", lwd = 2)
mtext("pH", side = 3, line=-1.1, adj = 0.75,
      font = 2, cex = 0.75)

plot(as.Date(fq.taiya$date_time), fq.taiya$turbidity,
     xlim=c(as.Date(start.graph),as.Date(end.graph)),
     ylim=turb.ylim,
     cex.axis = 0.75,
     xlab="",
     ylab="",
     main="",
     type="l")
#segments(as.Date("2011-07-26"), 56.7, as.Date("2011-09-13"), 131,
#         col = "white", lwd = 2)
mtext("Turbidity (NTU)", side = 3, line=-1.1, adj = 0.75,
      font = 2, cex = 0.75)

dev.off()

```


SOP 11: Five-Year Report (FQ_H Creation)

Version 1

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
-	Sept 2011	C. Sergeant	Initial version	1

Contents

	Page
1.0 Summary	118
2.0 Five-Year Report Format and Content	118
3.0 Contents of Results Section	119
3.1 Summary Figures	120
3.2 Time-Series Trend and Parameter Correlation Analysis	125
3.3 Comparison to Other Data Sets	127
3.4 Analytical Software	127
4.0 Monitoring Program Recommendations	128
5.0 Tips for Improving Readability of Results	128
6.0 Submission, Validation, and Dissemination of the Deliverable	128
7.0 Literature Cited	130

1.0 Summary

Beginning in 2016 and every five years thereafter, the Project Leader will conduct a detailed analysis of long-term status and trends in water quality data from the three network parks (SITK, GLBA, and KLGO). Additional regional datasets may be integrated with SEAN water quality monitoring to form comparisons over broader temporal and spatial scales. If the Project Leader requires additional expertise in order to complete the report, SEAN will acquire external assistance.

Important questions to be examined in five-year reports include:

- What is the seasonal variation of each water quality parameter?
- Do long-term positive or negative trends in water quality parameters exist?
- Are long-term water quality trends consistent across parks?
- What are reference conditions for water quality parameters in each park?
- Does long-term data suggest an emerging environmental shift from past conditions?
- Do water quality trends correlate to streamflow and weather patterns?

2.0 Five-Year Report Format and Content

The five-year report will be formatted and published as a NPS Natural Resource Technical Report (<http://www.nature.nps.gov/publications/NRPM/>). The goal of the report is to expand upon annual results by describing and interpreting long-term monitoring status and trends in a broader temporal and spatial context. Generally, the Introduction section will be similar to annual reports, while the Methods and Results sections will be supplemented with explanations of long-term and regional trend analyses commonly used with water quality datasets. The five-year report will include similar tables and figures from annual reports (SOP 10), thus, this SOP describes additional reporting beyond the scope of annual reports.

1. **Executive Summary:** Intended for park superintendents and managers; review program purpose and design; summarize Results and Discussion
2. **Introduction:** Present the monitoring program context, goals, and objectives
3. **Methods:** Describe study areas, field and analytical techniques, annual deviations from sampling prescribed in protocols, and the sources for external regional datasets
4. **Results:** Present tables and figures of annual and historical results, summarize long- and short-term regional or local trends, and describe anomalous or notable system-specific observations
5. **Discussion:** Generalize results in the context of monitoring program objectives and long-term questions, provide interpretation for long- and short-term trends or anomalies, briefly describe expected future sampling, what has gone well and should continue, and present recommendations and future considerations for new monitoring work

Acknowledgement of field crew, logistical supporters, document reviewers, contracted reporting assistance, etc. is included before the introduction.

3.0 Contents of Results Section

In the SEAN, four to five water quality parameters are measured hourly for five to six months each sampling season, producing thousands of lines of water quality data each year that must be summarized in an informative and concise manner. To achieve this goal and maintain long-term relevance, the results of five-year reports will be directly linked to the objectives described in the protocol narrative and the questions listed in Section 1.0 of this SOP. Below is the list of essential data reporting that must accompany each objective and the related, long-term questions. The proceeding sub-sections describe each of these report components in more detail. Each year, if the Project Leader discovers additional informative results through other exploratory analyses, reporting will expand beyond the essential components listed below.

- **Objectives 1 and 2:** Track the status and trends of each core water quality parameter; describe the timing and magnitude of seasonal and annual variation of each core water quality parameter; as data accumulates over time, place short-term variation in the context of observed long-term trends
 - **Related long-term questions:** What is the seasonal variation of each water quality parameter? Do long-term positive or negative trends in water quality parameters exist?

Report components: Temperature and turbidity mean/minimum/maximum summary (Figure SOP 11.1), annual mean temperature trends (Figure SOP 11.2), monthly box plots for conductivity, dissolved oxygen, and pH (Figure SOP 11.3), scatter plot matrix of pairwise parameter comparisons (Figure SOP 11.4), and Mann-Kendall tests for trend (Figure SOP 11.5).
- **Objective 3:** Evaluate whether state and/or federal water quality standards are met or exceeded (in the context of the five-year report, this objective will be interpreted more broadly, considering whether any monitored rivers are trending toward water quality regulatory thresholds or if there is an observed shift in water quality that signifies potential future exceedance)
 - **Related long-term questions:** What are reference conditions for water quality parameters in each park? Does long-term data suggest an emerging environmental shift from past conditions?
Report component: period of record and 90% confidence interval (Table SOP 11.1), comparison of state water quality criteria to measured parameter means and ranges (if no standards were exceeded, no comparison table is required)

Most results will be summarized in graphical form. Brief narratives summarizing general trends or notable results will support tables and figures. Graphic summaries and analyses presented in this SOP combine ideas from SEAN staff, other NPS scientists, Helsel and Frans (2006), Helsel and Hirsch (2002), and Hirsch et al. (1982).

Tables will be formatted in Excel and inserted into Word documents using Paste Special/Picture (Windows Metafile) commands; figures are produced and formatted in several common software

packages (Excel, SigmaPlot, or R). When possible, results from all three rivers (Salmon, Taiya, and Indian; potentially more depending on future monitoring program expansion) will be consolidated into a single panel.

3.1 Summary Figures

Temperature and turbidity are expected to display the highest degree of variability throughout the sampling season and will undergo more detailed initial analyses than specific conductance, dissolved oxygen concentration, and pH. If notable variability or seasonality exists in the latter three parameters, further analyses will be included in the five-year report.

3.1.1 Time Series

Average daily time-series data are plotted for water temperature at all sampling stations and for turbidity in the Taiya River (Figure SOP 11.1). To summarize seasonal trends of water temperature and turbidity, each time series includes the five-year daily mean, mean minimum, and mean maximum lines. Depending on the breadth of data, certain anomalous years or shorter time periods of interest are graphed separately from the average summaries, described in the Results text, or included in a detailed appendix.

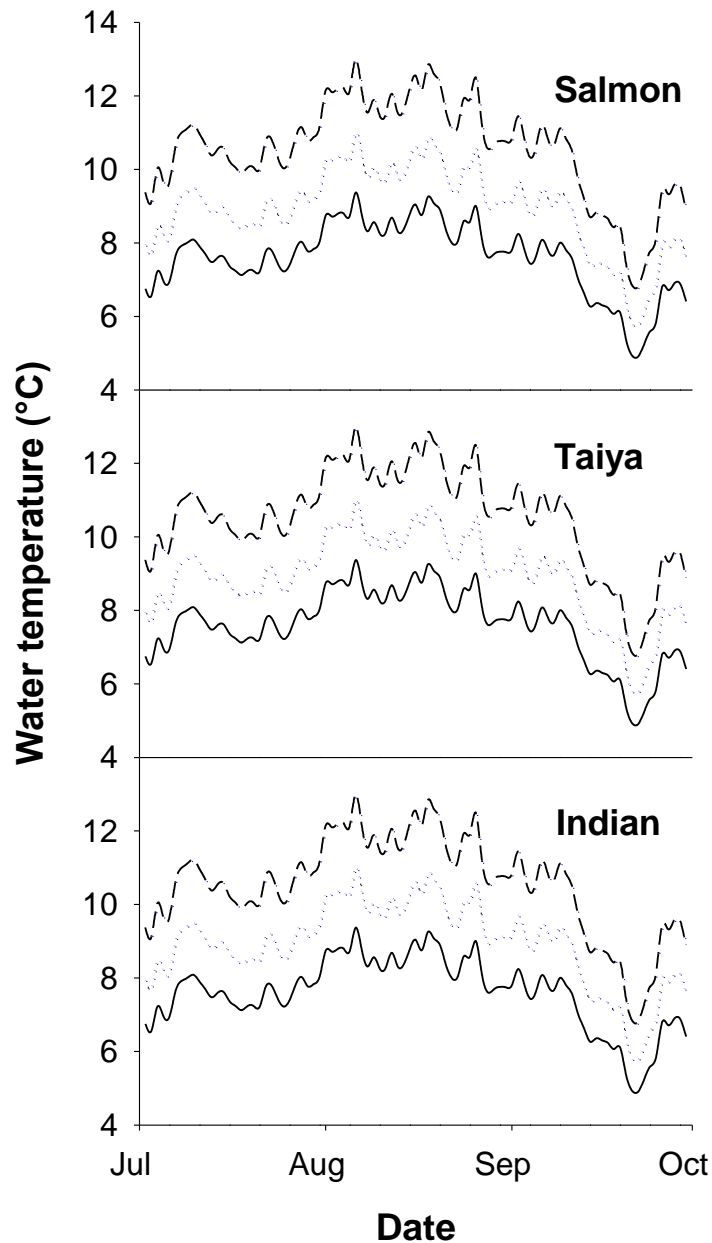


Figure SOP 11.1. Five-year daily mean (dotted), mean minimum (solid), and mean maximum (dashed) water temperatures for artificial data in the Salmon, Taiya, and Indian rivers.

Annual water temperature trends are summarized by scatter plots, where each point represents an annual mean temperature calculated from average daily mean values (Figure SOP 11.2). These graphs illustrate warming, cooling, or stable trends in annual water temperature over time. Indices such as these are important general indicators of climate shift and annual growth and survival conditions for all levels of organisms from bacteria to fish. If significant trends exist based on correlation coefficients (Kendall's tau; Section 3.2.2), regression analyses are an appropriate addition to this figure. When excessive data gaps exist, the Project Leader must justify the inclusion or exclusion of a seasonal mean. If considerable gaps occur through five years, monthly averages may be a more appropriate summary method.

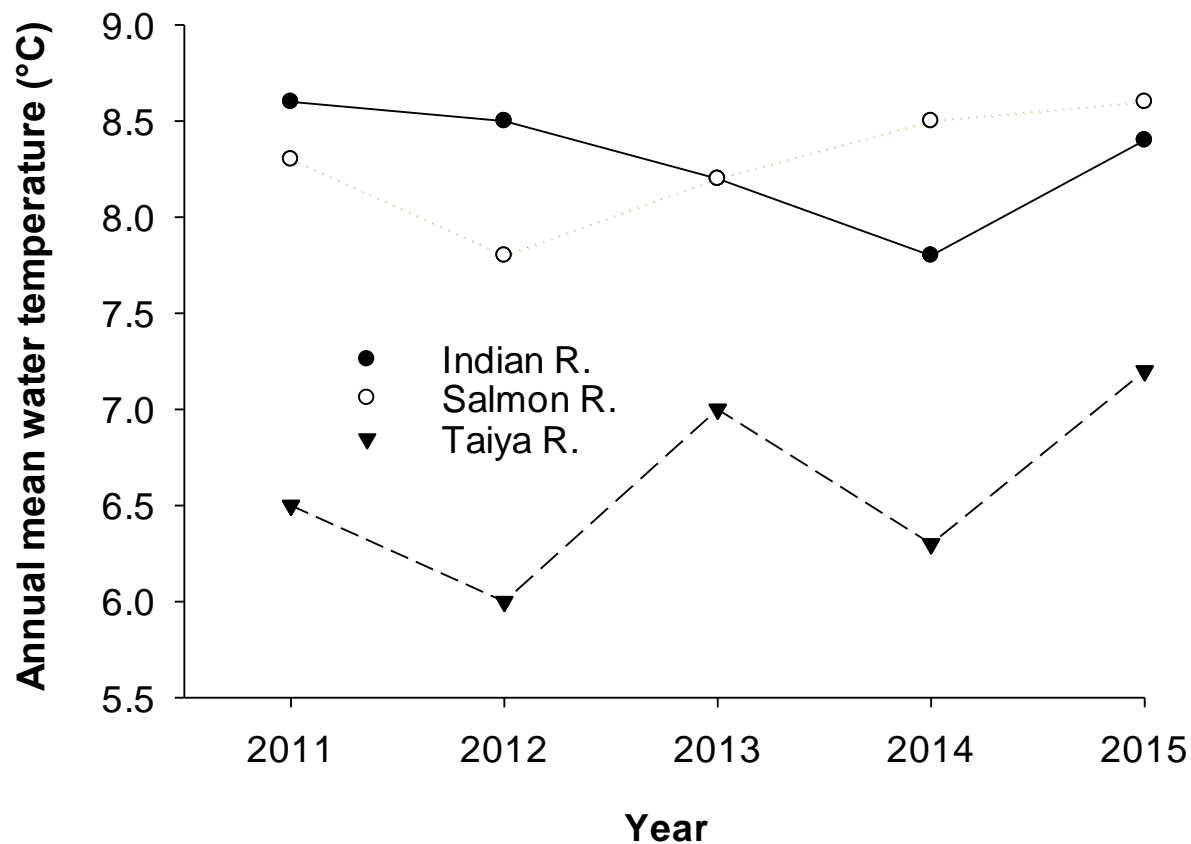


Figure SOP 11.2. Annual mean temperature using artificial data for the Indian, Salmon, and Taiya rivers.

To further describe long-term warming and cooling trends, the date of annual peak water temperature and turbidity are graphed by year as a scatter plot in a manner similar to figure SOP 11.2. In this case, the X-axis will again be the year, while the Y-axis will increase by day of year. If displaying results for three rivers becomes too cluttered for interpretation, a separate panel for each river is displayed.

Monthly summaries of each water quality parameter are described by box plots (Figure SOP 11.3). Monthly values will be averaged over all years combined.

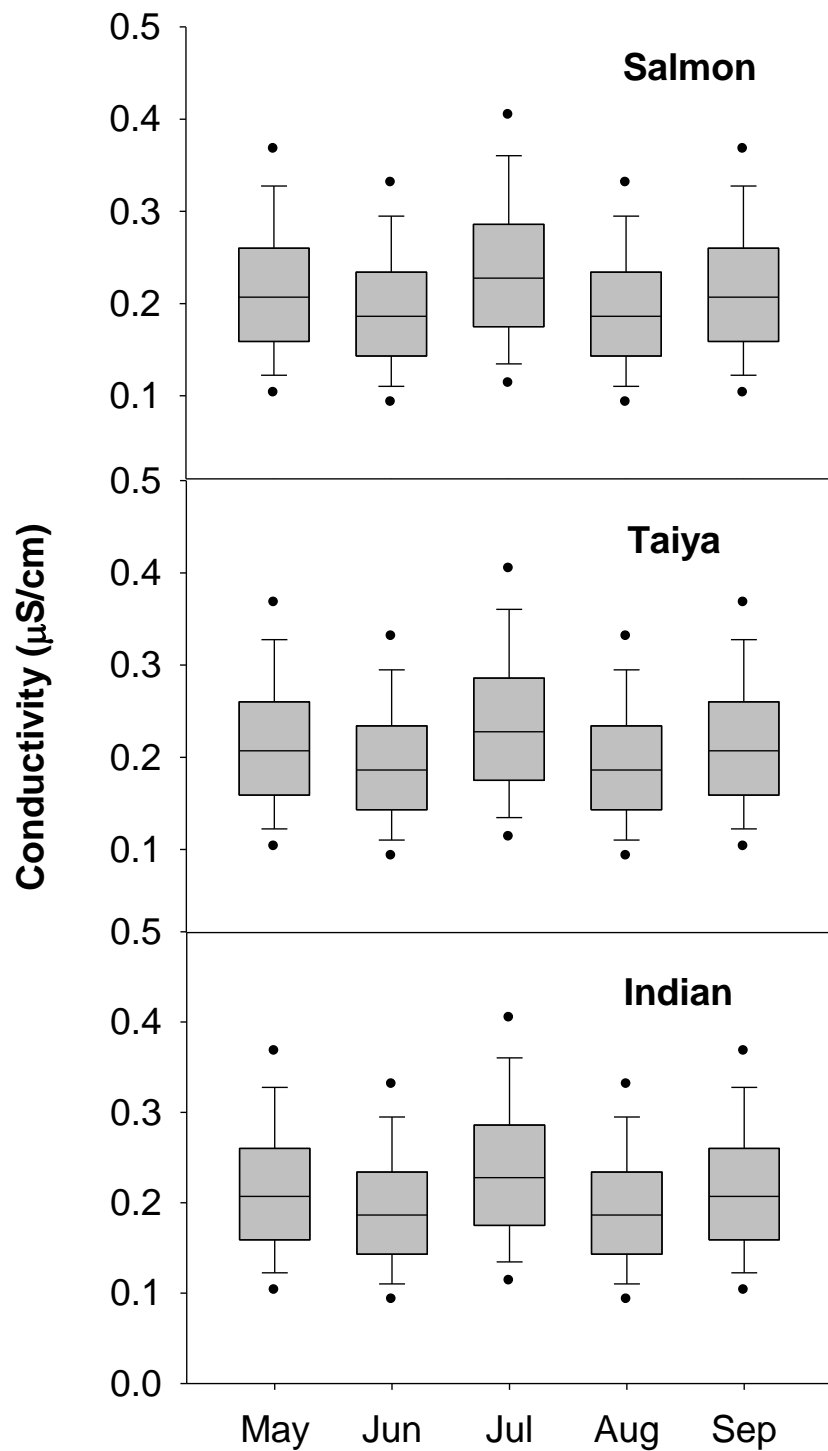


Figure SOP 11.3. Box plot example summarizing monthly water quality over a five-year period using artificial data for the Indian, Salmon, and Taiya rivers. Lines within the boxes represent median values, lines bounding the lower and upper portion of the boxes represent 25th and 75th percentiles, lower and upper whiskers represent 10th and 90th percentiles, and single points represent 5th and 95th percentiles.

3.1.2 Reference Conditions

Reference conditions for each water quality parameter are established by computing 90% confidence intervals around the mean value of each parameter. Regardless of the shape of the data distribution, a symmetric confidence interval around the mean based on a normal data distribution is appropriate due to the high number of observations from hourly sampling over five seasons (Central Limit Theorem). This presentation is especially useful when comparing data to established state water quality regulations or discussing the typical range of water quality conditions at each monitoring station (Table SOP 11.1).

Table SOP 11.1. Period of record and five-year 90% confidence intervals for each river and water quality parameter.

River	Parameter	Period of Record	No. observations	Confidence interval summary			
				Lower 90% confidence limit	Mean	Upper 90% confidence limit	Confidence interval range
Salmon	Conductivity ($\mu\text{S}/\text{cm}$)	1 May 2012 to 30 September 2016	683	0.08	0.25	0.42	0.34
	Dissolved Oxygen (mg/L)						
	Dissolved Oxygen (% Sat)						
	pH						
	Temperature ($^{\circ}\text{C}$)						
Taiya	Conductivity ($\mu\text{S}/\text{cm}$)						
	Dissolved Oxygen (mg/L)						
	Dissolved Oxygen (% Sat)						
	pH						
	Temperature ($^{\circ}\text{C}$)						
Indian	Conductivity ($\mu\text{S}/\text{cm}$)						
	Dissolved Oxygen (mg/L)						
	Dissolved Oxygen (% Sat)						
	pH						
	Temperature ($^{\circ}\text{C}$)						
	Turbidity (NTUs)						

3.1.3 Correlation between Two Parameters

Often, two water quality parameters can be correlated, but the magnitude or pattern of correlation differs across systems depending on the local dynamics of environmental forces such as glacial input, geology, and climate. Scatter plot matrices for each river will be a useful tool for quickly displaying and diagnosing potential correlation between any two water quality parameters (Figure SOP 11.4).

Several documented examples illustrate the importance of pair-wise comparisons for elucidating the mechanisms underlying seasonal trends in water quality parameters. Among other environmental factors, dissolved oxygen concentration can change with water temperature. In less productive river systems, water temperature may be the main factor affecting DO concentration, while no response is seen in relation to turbidity or pH. The relationship between pH and conductivity can be influenced by glacial or snow meltwater and streambed geology. As glacially-influenced rivers such as the Salmon experience spring run-off, turbidity will be expected to increase while conductivity decreases. This relationship can be confirmed with a pair-wise comparison. Some relationships may be seasonal. The Project Leader will examine relationships during discrete time periods to determine whether pair-wise comparisons should be summarized on a seasonal or annual basis. In general, observing relationships such as the examples listed here will lead to an increased understanding of how the unique environments of each river system affect the observed values of water quality parameters.

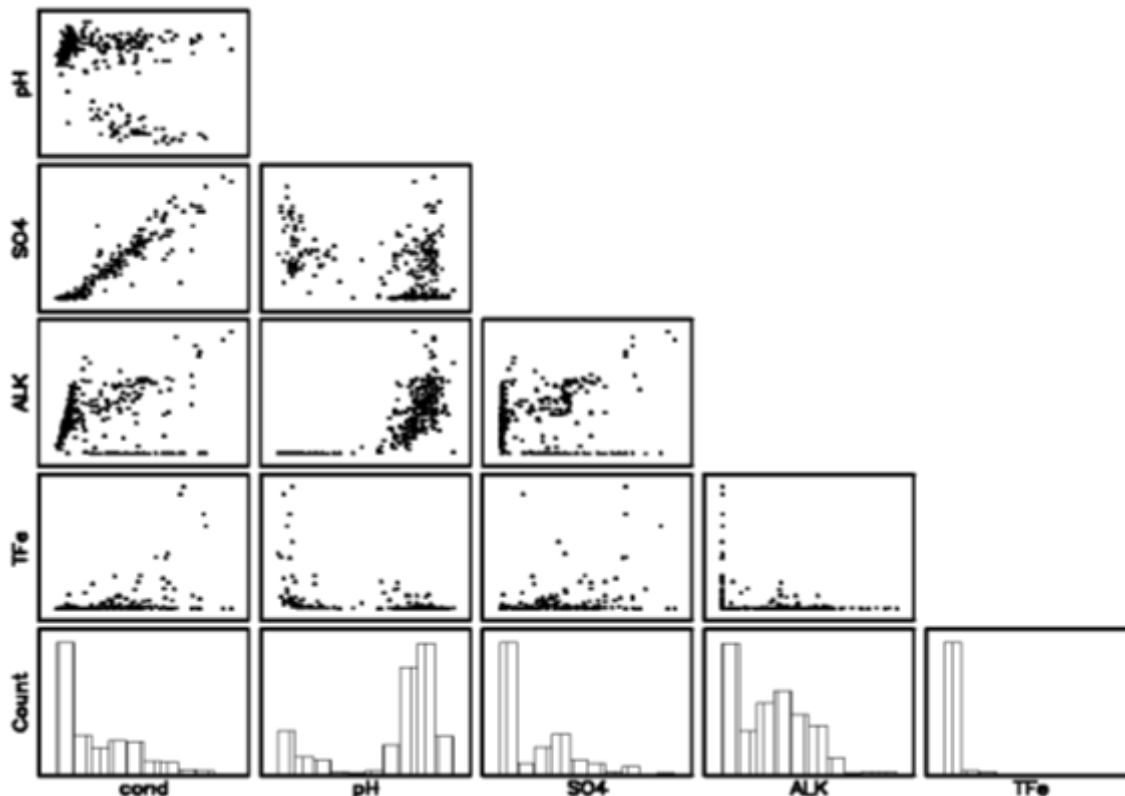


Figure SOP 11.4. Example scatter plot matrix for water quality data from Helsel and Hirsch (2002). Each point represents an individual measurement. The bottom row uses histograms to illustrate the distribution of values for each water quality parameter.

3.2 Time-Series Trend and Parameter Correlation Analysis

In addition to the summary figures described above, the suite of Mann-Kendall tests, associated correlation coefficient, and slope estimator are used to quantify trends. Five-year report authors may need to implement further analyses based on preliminary results and visually inspecting summary figures. In all cases, though, final report components are limited to those that support the clearest interpretations and do not move outside the scope of the monitoring objectives set forth in section 1.0 in this SOP and section 1.6 of the protocol narrative.

3.2.1 Time-Series Trends

One of the most commonly accepted and informative water quality analyses is the Mann-Kendall test for trend. The non-parametric Mann-Kendall test evaluates whether a dependent Y-axis variable (e.g., temperature) changes over time in a positive or negative direction regardless of the function's shape. The test is robust for water quality data that are typically not normally distributed.

A subset of the Man-Kendall test is the seasonal Kendall test, in which monthly medians for a selected parameter are calculated for each monitoring year (equating to six medians per year [May-October] for the freshwater water quality program). The test separates the effects of seasonality from the overall annual trend to determine if there is a single direction (monotonic) trend over time. If a significant trend is detected, the seasonal Kendall slope estimator (also

known as the Sen or Theil-Sen slope) describes the magnitude of the trend. Trends can be linear or non-linear over the time series. One caution for test result interpretation is that cyclical trends cannot be discerned. Mann-Kendall tests are discussed in great detail in Helsel and Hirsch (2002), Helsel and Frans (2006), and Hirsch et al. (1982).

Serial correlation, typically positive autocorrelation, may be an issue with water quality time-series data, and p-values resulting from Mann-Kendall tests can be corrected for autocorrelation. However, time series under 10 years in length are not usually corrected for autocorrelation (Helsel and Frans 2006). The presence of autocorrelation is tested by calculating Kendall's tau on the residuals of adjacent data points. Significant values ($p < 0.10$) represent autocorrelation. This process is described in Helsel and Frans (2006; Section 9.5.4).

Trend test results from Mann-Kendall (within the same month over multiple years) or seasonal Kendall (over multiple years) tests will be summarized in a single figure (Figure SOP 11.5).

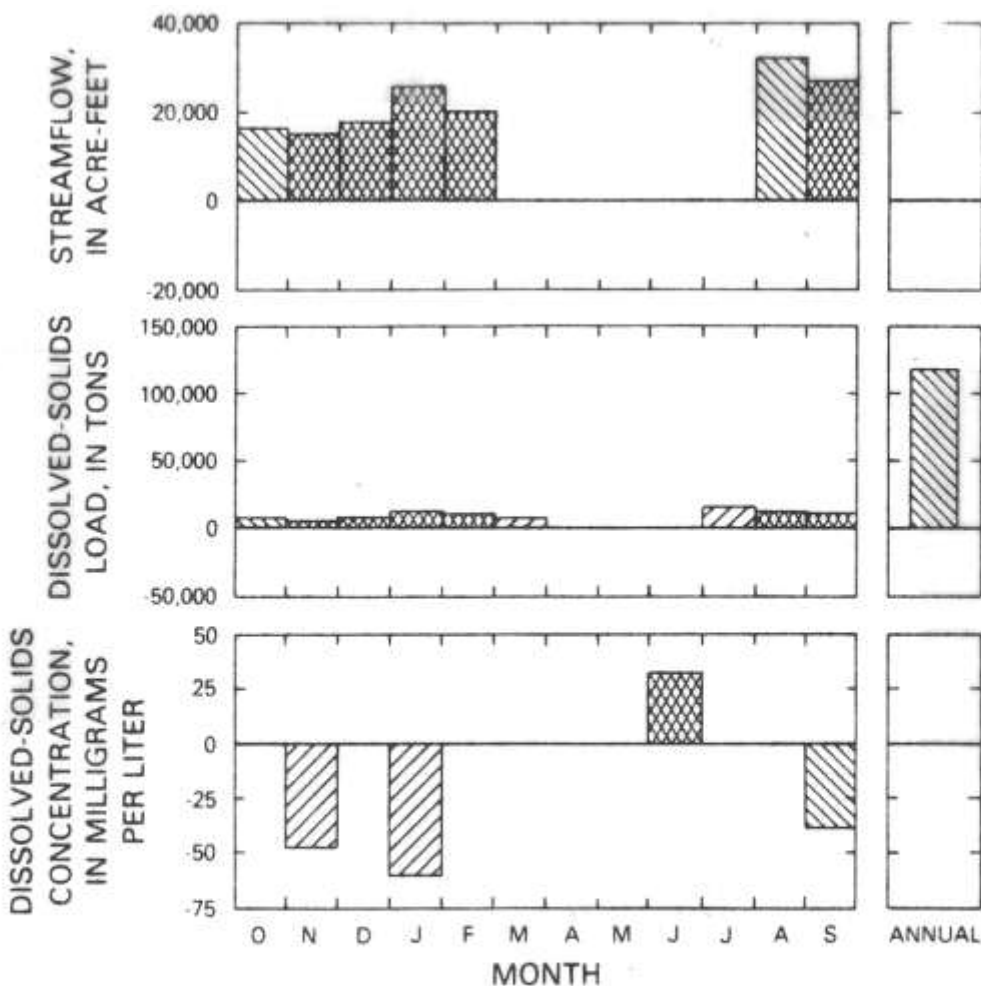


Figure SOP 11.5. An example of graphically summarizing results from monthly Mann-Kendall and seasonal Kendall tests from Helsel and Hirsch (2002). Bars represent the magnitude of positive or negative trends for each water quality parameter.

3.2.2 Scatter Plot Correlation

For each scatter plot in figures SOP 11.2 and 11.4, the correlation coefficient Kendall's tau is calculated with a significance level of $\alpha = 0.10$. Non-parametric correlation coefficients such as Kendall's tau are preferable over parametric correlation coefficients for describing water quality relationships because these data are usually not normally distributed and tau is not sensitive to outliers. A tau p-value less than 0.10 signifies a measurable positive or negative relationship between two variables, regardless of the function's shape. Linear or local regression will aid in understanding the shapes of relationships between monitored water quality parameters in each river, but time-consuming regression procedures are only necessary when visually obvious correlation patterns are present and supported by Kendall's tau values.

3.3 Comparison to Other Data Sets

Often, water quality measurements are closely linked to other environmental parameters such as weather and streamflow. At a minimum, when available, streamflow in each monitored river will be compared to core water quality parameter values. Parameters such as snow pack and air temperature will likely affect the observed patterns in water quality data, as well, and will be included in the five-year report when significant correlations are found. As more parameters are compared to water quality data, the Project Leader is encouraged to explore multivariate modeling and multiple regression techniques to help determine complex patterns among several climate and water quality variables (e.g., effect of snow pack and precipitation on conductivity).

Streamflow data sets:

- Salmon River does not currently have a stream gage, but flow peaks and valleys can be discerned from the Montana Creek gage (USGS 15052800) in Juneau. While Montana Creek has a smaller drainage area, its long-term data set (1965 to the present) and relative proximity to the Salmon River makes it the nearest available and relevant gage for comparison. If available, Falls Creek discharge data collected by the Gustavus Hydroelectric Company is a more accurate proxy for Salmon River discharge.
- Taiya River gage near Skagway (USGS 15056210; partially funded by NPS)
- Indian River gage in Sitka (currently maintained and operated by NPS)

Weather station data sets:

- GLBA fuel dock
- NPS weather station data in KLGO (Taiya River Bridge, Klondike Highway Summit, Sheep Camp, Chilkoot Pass, Moore Creek, Gold Lake)
- FAA airport data from SGY, GST, and SIT
- NOAA/NWS Cooperative Observer 15-minute Precipitation Network
- USDA-NRCS Snowpack Telemetry (SNOTEL) Network (including Moore Creek north of Skagway)

3.4 Analytical Software

The R package 'wq' will be used for calculating Kendall's tau, slope estimators (mannKen), and seasonal Kendall tests for trend (SeaKen). R can efficiently produce scatter plot matrices (Figure SOP 11.4). Data will be formatted in Excel spreadsheets before importing into R. Over time, the

Project Leader will develop an appendix of useful R code and Excel data formatting tips to improve the efficiency of future reporting.

4.0 Monitoring Program Recommendations

In addition to interpreting results, the Discussion section of each five-year report will include descriptions of the pros and cons of the current monitoring approach, recommended corrective actions for the long-term program, and future considerations for expanding the program or conducting alternate analyses.

5.0 Tips for Improving Readability of Results

4. **Monitoring program context:** To retain continuity across annual reports, structure results and narrative in the context of the monitoring program's objectives. Results that may be interesting but are unrelated to program objectives are placed in discrete sub-sections within the Results section but separate from the main results. If many interesting results occur, or a separate research or monitoring program needs to be discussed in relation to water quality results, an appendix will be added.
5. **Parallel structure:** When listing results in graphs, tables, or narrative, consistently refer to rivers in alphabetical order by park: Salmon (GLBA), Taiya (KLGO), and Indian (SITK). When referring to combined water quality figures, list conductivity, dissolved oxygen, and pH in alphabetical order. Repeating these patterns throughout the annual report will allow the reader to develop a reading pattern and comprehend more quickly.
6. **Black and white:** Use only black and white or grayscale figures. This avoids problems with color-blindness or non-color printers.

6.0 Submission, Validation, and Dissemination of the Deliverable

The final version of FQ_H is reviewed by the SEAN Program Manager and generated as a PDF file by the Project Leader, who delivers it to the Data Manager for the validation checks defined in Appendix D. After the valid report is certified by the Project Leader, the Data Manager installs the final PDF in the auxiliary repository, creates a web link for it, updates the Deliverable Product Tracking grid, and forwards the final FQ_H to the NPS IRMA Data Store.

1. Program Manager Tasks

1. Review the final Word report document.
2. Apply any essential corrections.
3. Forward to Project Leader.

2. Project Leader Tasks

1. Generate a PDF file from the original Word Document.
2. Submit both the PDF and DOCX files via email attachment to the Data Manager for validation. Specify in the message body it is deliverable FQ_H, as defined in protocol FQ-2013.1.

3. Data Manager Tasks

1. On receipt of the submission, assign the next formal Submission Number to this file, as found in the master Submission_Log table.
 1. Use the “Update Submission Log” web tool at the data management site:
http://165.83.57.239/0_submission_update.aspx.
 2. Complete Submission_Log details up through the Submission_Date column.
2. Save the attached files to the staging area for validation at:
\\inpglbafs03\data\SEAN_Data\Staging\FQ\FQ_H\nnnn where “nnnn” is the assigned submission number.
3. Rename the files to FQ_H-yyyy.PDF and FQ_H-yyyy.DOCX, where “yyyy” is the year of report publication.
4. Validate the two files according to current criteria.
5. Record validation summary data in the Submission_Log using the web tool.
6. If submission fails mandatory criteria, reply with a “failure email” that includes:
 1. The submission number assigned.
 2. The deliverable ID.
 3. The protocol ID.
 4. Documentation listing all the specific mandatory criteria failed.
7. If submission passes mandatory criteria, reply with a “success email” that includes:
 1. The submission number assigned.
 2. The deliverable ID.
 3. The protocol ID.
 4. Documentation listing any specific optional criteria failed.
 5. Request to certify deliverable as complete.

4. Project Leader Tasks

1. On receipt of a failure email:
 1. Make corrections so the deliverable meets mandatory criteria.
 2. Make another submission with corrected deliverable candidate.
2. On receipt of a success email:
 1. After reviewing any optional criteria violations, if the deliverable is acceptable reply with a “certification email” stating the deliverable is certified and may be disseminated.
 2. If it is unacceptable:
 1. Reply with a “withdrawal email,” stating the deliverable is withdrawn.
 2. Take remedial action to obtain a corrected deliverable.
 3. Restart the process from the beginning.

5. Data Manager Tasks

1. On receipt of a withdrawal email:
 1. Mark the withdrawal in the Submission_Log’s Status column using the web tool.

2. *File the email in the Data Manager's email folder named "SEAN Data Management / FQ".*
3. *Terminate the process.*
2. On receipt of a certification email:
 1. *File the email in the Data Manager's email folder named "SEAN Data Management / FQ".*
 2. *Due to the nature of these data, NO sensitive information is in the deliverable.*
 3. *Copy the two submitted files to test environment at:*
\\inpglbafs03\data\SEAN_Data_Mgmt\Web_Sites\SEAN-Test\AuxRep\FQ\FQ_H.
 4. *Create web page link to the new PDF, but not the DOCX*
 1. **Mark the certification in the Status column in Submission_Log using the web tool.**
 2. **Propagate from test to production environment.**
 3. **Update the annual deliverable tracking spreadsheet showing date of completion for FQ_H**
 5. *Verify that the final document is in the NPS IRMA Data Store and is marked for public access.*

7.0 Literature Cited

- Helsel, D. R., and L. M. Frans. 2006. Regional Kendall test for trend. *Environmental Science and Technology* **40**(13):4066–4073.
- Helsel, D. R., and R. M. Hirsch. 2002. Statistical methods in water resources. Chapter A3 in *Techniques of water-resource investigations of the United States Geological Survey, Book 4, Hydrologic analysis and interpretation*. Available from <http://water.usgs.gov/pubs/twri/twri4a3/> (accessed 1 September 2011).
- Hirsch, R. M., J. R. Slack, and R. A. Smith. 1982. Techniques of trend analysis for monthly water quality data. *Water Resources Research* **18**(1):107–121.

SOP 12: NPStoret Submission (FQ_I Creation)

Version 1

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
-	Aug 2011	Bill Johnson	Initial version	1

1.0 Summary

At the end of each season, once the FQ_F database updates have been certified, the year's data are submitted to the NPS Water Resource Division (WRD) for inclusion in their NPSTORET database. This serves both as an archive for service users as well as a platform for updating the national water quality database maintained by the U.S. Environmental Protection Agency.

The step-by-step details of this process were not fully specified as of publication of this protocol because WRD is currently defining a new mechanism and set of standards for submitting data to NPSTORET. The process of creating the FQ_I deliverable will be documented once the new mechanism has been established.

SOP 13: CSV Data (FQ_J Creation)

Version 1

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
-	Sept 2011	Bill Johnson	Initial version	1

1.0 Summary

After the year-end FQ_E deliverable is certified, the proprietary YSI, Inc. data are converted to commonly readable comma-delimited file form and stored in a file with extension CDF. One CDF file is produced for each site/year, based on the most recent FQ_E downloaded from each site. If the final FQ_E from a site is defective, the Project Lead uses earlier FQ_Es to recover the most observations possible.

An internal Southeast Alaska Network (SEAN) augmentation program is executed to add columns to the CDF file that support data management and quality control functions, resulting in an augmented file whose name ends in CSV. The augmentation program also pulls grading scores into the CSV from certified FQ_C site visit worksheets. The Project Leader flags erroneous values and exceptions in each file. The files are packaged into on ZIP file. The Project Lead and Data Manager iterate validation cycles until the CSV product is certified. The certified product is made available on the web.

2.0 Detailed Steps

1. Project Leader: Assemble Baseline Deliverable

- Obtain the season's certified FQ_E .dat sonde output files.*
 - Browse the production web site to "Raw Sonde Data" in the freshwater water quality main page.
 - Download the correct zip file to \\INPGLBAFS03\DATA\SEAN_Data\Work_Zone\FQ\yyyy\FQ_J\, where "yyyy" is the current year of study, creating the folder if necessary.
 - Unzip the file contents into the ...\\FQ_J\ directory.
- Build the CDF from the correct subset of .dat files.*
 - Review the last .dat of the year for each site by visualizing it in EcoWatch proprietary software.
 - Normally this should contain all the data for the year for a single site (Figure SOP13.1), and the earlier checkpoint .dat files are of no interest.*
 - However, if it does not cover the entire period, review the monthly checkpoint files to determine if the missing data are available in one (or more) of them.*
 - If needed data for a site are for some reason split among two or more files, the Project Leader will need to extract CDFs from each site and cut and paste one*

single CDF file out of them using Excel or other software. The timestamp of each record must be used to determine exact location of splices.

4. In the event data are missing and unrecoverable, there is no work-around. The CDF file for the year will have gaps.

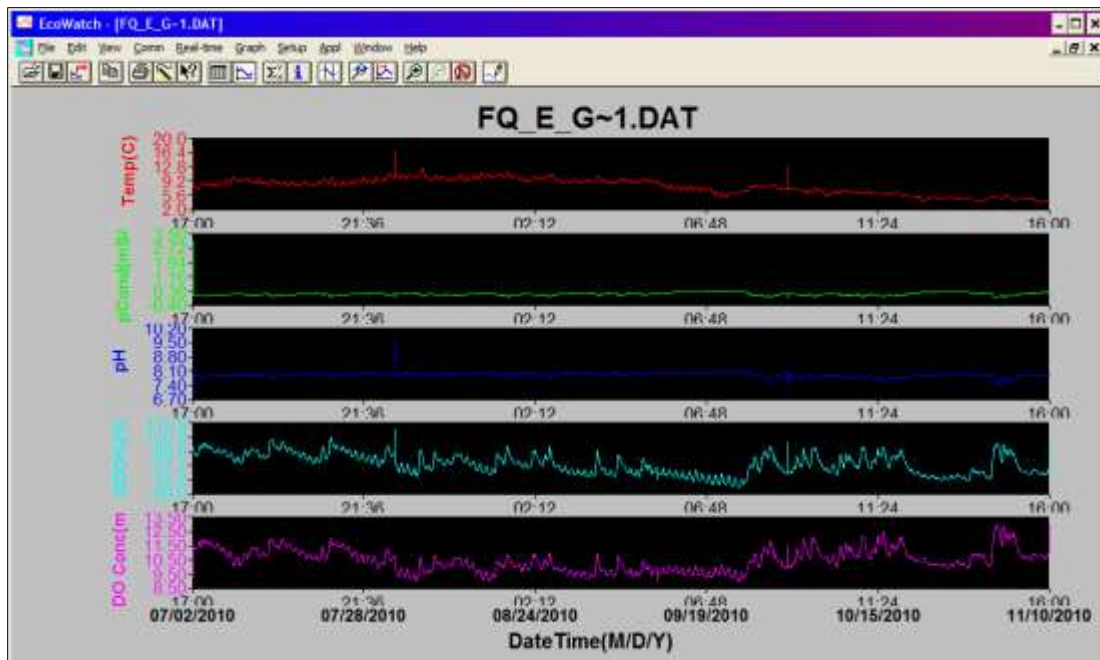


Figure SOP 13.1. EcoWatch depiction of a complete .DAT file covering the entire season. Note the characteristic temperature spikes encountered when the sonde was pulled from the water during site visits.

2. For each site, generate a CDF file using EcoWatch.
 1. Start up the proprietary EcoWatch application available from YSI, inc.
 2. Do a FILE/OPEN on the most recent .dat file for the site. EcoWatch will typically read the data and draw graphs.
 3. Verify all needed parameters have been enabled in this file (Figure SOP13.2).
 1. Click on the menu sequence **SETUP/PARAMETERS/ADD/REMOVE...**
 2. In the dialog box that appears, the list labeled “Selected Parameters” must contain these values: “DateTime”, “Temp”, “SpCond”, “pH”, “ODO%”, and “ODO Conc”.
 3. If the selected parameters are incorrect, click on items to add or remove and press the appropriate screen button.

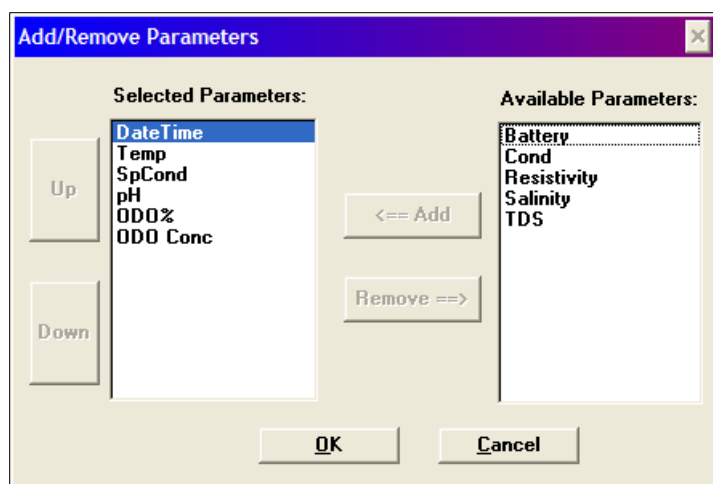


Figure SOP 13.2. Selecting the correct parameters for the CDF output file.

4. *Export the data to a comma-separated value file.*
 1. Click on the menu sequence **FILE/EXPORT/CDF/WMF...**
 2. In the **FILE EXPORT** dialog box that appears, be sure the radio button is selected for “Comma Delimited (CDF).” Also ensure the “Separate Time/Date” check box is checked on.
 3. Navigate the output to **INPGLBAFS03\DATA\SEAN_Data\Work_Zone\FQ\yyyy\FQ_J** (Figure SOP13.3).
 4. Accept and note the default filename provided. It is not practical to alter it at this stage. If this is not the first export for this year/site, then you will be asked whether to replace an older file of the same name – click **YES**.
 5. Press the **EXPORT** button. A file will be created, though no screen message announces this.
 6. Using Windows Explorer, locate the output file (by timestamp) and rename it to **FQ_J_ss_yyyy.CDF**, where **ss** is the formal site code as defined in Appendix A, and **yyyy** is the year data were recovered in.
5. *Repeat for each site.*

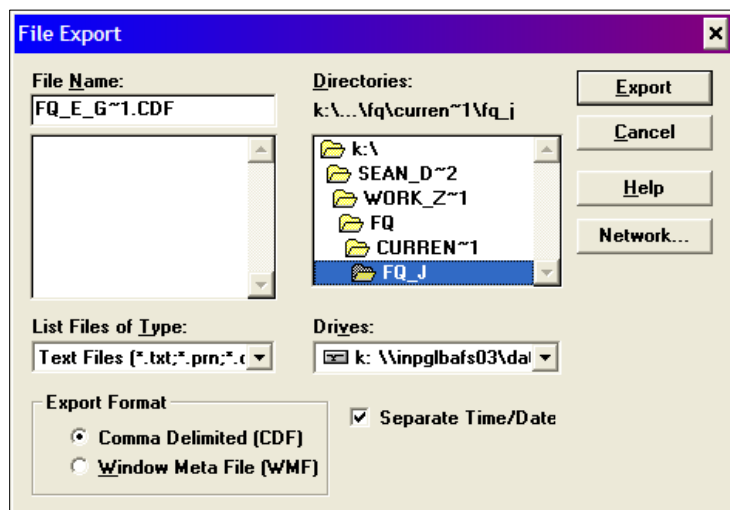


Figure SOP13.3. Specifying the comma delimited file export type and location.

2. Project Leader: Augment the CDF Content with Metadata and Grading.

1. *Invoke the FQ_J Augmenter tool on the data management website to apply a onetime adjustment, adding additional columns to each CDF, assigning data grades where possible, and saving new versions having CSV extensions.*
2. *Use the dropdown lists to specify the year on which to work. It may take a moment to verify there is a certified FQ_C available for the year.*
3. *The application will find every file created in step 1 having the standard name FQ_J_ss_yyyy.CDF.*
4. *The application will generate in that same folder output files named FQ_J_ss_yyyy.CSV, one for each site for which there is a CDF.*
5. *Fill the required data fields on the screen to reflect metadata for the file; this is available from the FQ_C site visit worksheets as well as the text of transmittal emails.*
6. *Press the button to create the augmented files.*

3. Project Leader: Flag the Data Quality for Each CSV.

1. *Review optional errors in previous validation findings of FQ_J.*
2. *Review FQ_C certified site visit worksheets online and note exceptions that indicate questionable or invalid data.*
3. *Perform any visualizations or analyses, such as time series graphing, required to detect questionable parameter readings due to events listed in Section 4 below.*
4. *Open each site's file in Excel or other software and assign Record Qualities.*
 1. *Assign each sensor's record_quality column with "0" for good when there is no question as to its correctness. This is the default set by the Augmenter.*
 2. *Mark data quality as "1" if it is not possible to ascertain the validity of a reading. This case typically occurs when the site visit and maintenance logs have been lost for an instrument and it is not known whether or not exceptions were encountered. Then enter a quality comment explaining why "1" was assigned.*
 3. *Mark sensor reading quality as "2" where appropriate to indicate questionable values, which may or may not be suitable for particular researchers' purposes. Then enter a quality comment explaining why "2" was assigned. Reasons may be noted as comments on the site visit worksheets. Typical reasons for assigning "2" include:*
 1. *Inconsistent sonde readings with no known environmental cause.*
 2. *Suspected tampering or vandalism.*
 3. *Deviation from proscribed protocol methodology.*
 4. *Mark quality as "3" where appropriate to indicate invalid values that may not be used for any purpose, as may occur when an instrument is physically damaged. Then enter a quality comment explaining why "3" was assigned. Typical reasons for "3" include:*
 1. *Failed sensor.*
 2. *Weak batteries.*
 3. *Physical sonde damage.*
 4. *Scrambled .DAT file recorded.*
 5. *Sonde washed out.*

5. For any record_quality that is changed from zero, its corresponding data_grade should be deleted. Data_grade is to be present only for good records.
6. For records affected by exceptional circumstances noted on the site visit forms it may be useful to explain these in the COMMENTS column near the end of the record.
7. Resave the processed file as CSV, but leave it open.
5. *Flag erroneous values*
 1. Using expert knowledge and the criteria specified in SOP 2, determine any value of any sensor that is an erroneous value.
 2. Change the value of its corresponding erroneous value attribute to 'Y'. No other value is acceptable.
 3. Resave the correct CSV.
 4. Close the file.
6. *Repeat for each site.*

4. Project Leader: Build and Submit the Deliverable File.

1. *Use Winzip or similar software to generate a single archive file in ...\\yyyy\FQ_J\ containing all the CSV files in that folder.*
2. *Rename the deliverable to FQ_J_yyyy.ZIP, where yyyy is the calendar year represented.*
3. *Submit the candidate deliverable for validation by sending a formal email to the Data Manager specifying that FQ_J as defined in protocol FQ-2013.1 is available for review. Also specify which year the data cover.*

5. Data Manager Tasks

1. *On receipt of submission email, generate a new submission record using the tool on the data management web site. Fill in the details through the Submission Date field.*
2. *Create a subdirectory bearing the name of the assigned submission number in \\NPGLBAFS03\DATA\SEAN_Data\Staging\FQ\FQ_J\.*
3. *Copy into the subdirectory the FQ_J_yyyy.ZIP file from \\NPGLBAFS03\DATA\SEAN_Data\Work_Zone\FQ\yyyy\FQ_J\.*
4. *If this is the first submission of FQ_J for the year, update the deliverable tracking spreadsheet with its date.*
5. *Execute the automated validation process on the data management web site. The results will be automatically recorded on the submission log.*
6. *If submission fails mandatory criteria, reply with a "failure email" that includes the submission number assigned, deliverable ID, protocol ID, year covered, and the "findings.htm" file generated during validation which details the file faults.*
7. *If, instead, submission passes all mandatory criteria, reply with a "success email" that includes the submission number assigned, deliverable ID, protocol ID, year covered, the "findings.htm" file generated during validation which will detail option errors, and a request to certify the deliverable as complete.*

6. Project Leader Tasks

1. *On receipt of a failure email:*
 1. *Open the underlying site CSV files with Excel and apply corrections to resolve the listed mandatory errors.*

2. Consult with the Park Lead if necessary.
3. Restart the submission process from the beginning.
2. *On receipt of a success email:*
 1. Review any failed optional criteria.
 2. If the optional faults are acceptable, then reply to the Data Manager with a “certification email” stating the deliverable is certified and may be disseminated.
 3. If the faults are unacceptable, then reply with a “withdrawal email” stating the deliverable candidate is to be withdrawn. Then take remedial action to correct the optional faults and restart the submission process from the beginning.

7. Data Manager Tasks

1. *On receipt of a withdrawal email:*
 1. Mark the withdrawal in the Submission_Log’s Status column using the tool on the data management web site.
 2. Terminate processing.
2. *On receipt of a certification email:*
 1. Verify no sensitive information is in the deliverable. Products containing sensitive information cannot be disseminated. (Sensitivity is unlikely for this deliverable.)
 2. If the deliverable is judged as sensitive:
 1. *Copy the submitted file to test environment at AUXREP\FQ\FQ_J\SENSITIVE\.*
 2. *Update the Submission_Log’s Status to sensitive.*
 3. *Update the test web site with an entry for this year marked to be sensitive and closed.*
 4. *Propagate from test to production environment.*
 5. *Verify deliverable is NOT accessible from production web site.*
 6. *Update the deliverable tracking spreadsheet with the date of completion for FQ_J.*
 3. If the deliverable is judge not to be sensitive:
 1. *Copy the submitted file to test environment at AUXREP\FQ\FQ_J\.*
 2. *Propagate from test to production environment.*
 3. *DO NOT verify deliverable is accessible from production web site. Because FQ_J is expected to be replaced by a deliverable that conforms to upcoming guidance from NPS Water Resources Division, FQ_J is not to be disseminated until further notice.*
 4. *Mark the certification in the Status column in Submission_Log.*
 5. *Update the deliverable tracking spreadsheet with the dates of completion and dissemination for FQ_J.*
3. *Update the scope of the formal deliverable metadata so it includes this new date range.*

SOP 14: Managing the Production Environment

Version 1

Revision History Log:

Prev. Version #	Revision Date	Updated By	Changes Made	New Version #
-	Sept 2011	Bill Johnson	Initial version	1

1.0 Summary

In order for most SEAN deliverables to be disseminated to the public, they must be installed in the NPS production environment managed by the Natural Resource Stewardship and Science Directorate (NRSS) in Fort Collins, Colorado. Certain of the deliverables must also be installed in production repositories, such as the NPS IRMA Data Store and NPStoret database. In order for production content to be generated, various steps must be performed in SEAN's staging environment. Once content is built and verified in the staging environment, it is copied to production for permanent storage and publicly-accessible dissemination.

Most of the detailed SOPs in this protocol end with a reference to propagating the final deliverable into production. This is an implicit reference to this SOP. Not all deliverables are handled in the exact same manner, so methods for installing them into production vary.

2.0 Schematic of the Environments

Figure SOP 14.1 illustrates the major components in the SEAN staging and NRSS production environments. References are also made to SEAN's development and test environments. Details of their operation are not germane to moving deliverables from staging to production, and will not be discussed here. Managing those two environments is explained in SEAN Data Management Plan SOP 303 – Organization of Development, Test/Integration, and Production, in Johnson and Moynahan 2008.

3.0 Components of the Environments

Major components of the staging environment include the Staging Directory, the Data Management Web Server, the Staging Database, and the Master Auxiliary Repository. The Staging Directory is a folder on SEAN's local file server used to collect submitted productions and feed them into validation and certification processes. The Data Management Web Server is an internal-only website holding applications used to: validate some deliverables; create certain deliverables; report information used as the basis for other deliverables; and actively track the status of all deliverables in process. The Staging Database is a SQL database used to hold the final FQ_F product as well as the deliverable status tables. The Master Auxiliary Repository is a set of folders and files housed on the local SEAN file server. It contains all certified deliverables except for FQ_F, which can only exist on a database server.

The production environment consists of the Production Database, the Replica Auxiliary Repository, and the Production Web Server. The Production Database houses all final FQ_F

data. The Replica Auxiliary Repository is a mirror of the Staging Auxiliary Repository. (This is done because NPS security technicians do not permit the production environment to directly access the Staging Auxiliary Repository.) The Production Web Server houses the public dissemination point. It draws content from the other two components.

Two additional production environments, which receive copies of certain items from the Master Auxiliary Repository, are NPStoret and the NPS IRMA Data Store. Delivering content to these repositories is SEAN's only role and responsibility in their management.

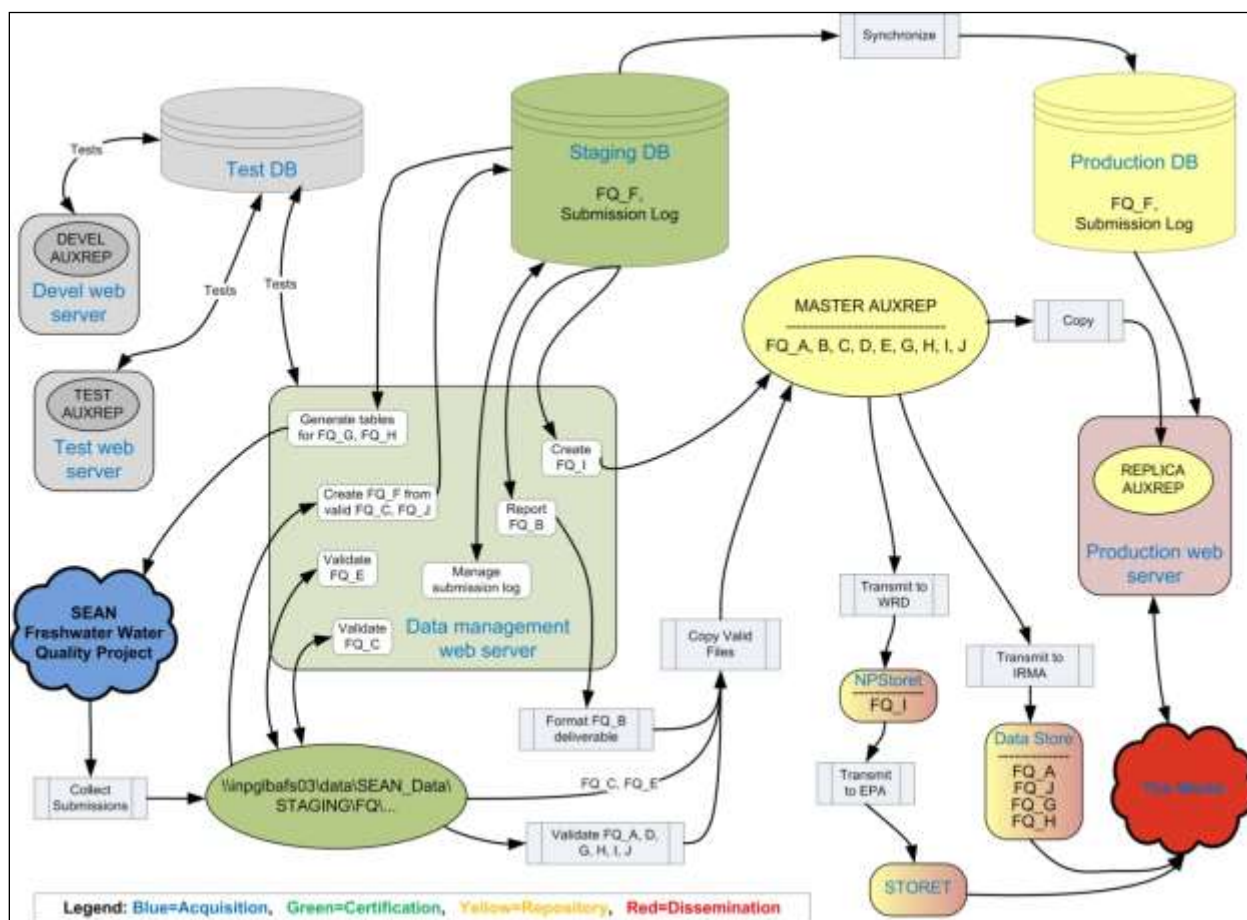


Figure SOP 14.1. Components of the staging and production environments. Coloring indicates the functional realm of each component, as defined in the SEAN data management plan. Rectangles depict the data management tasks required to move a product from one component to the next. Internal functions provided by the data management web server related to freshwater quality are also listed.

4.0 Data Management Processes

Figure SOP 14.1 shows as rectangles specific tasks needed to move a deliverable from the submission-to-staging through the production-dissemination states. These are primarily data copying steps achieved either by file transfer or by SQL database synchronization. No attempt will be made to detail specific commands and IT processes to accomplish these particular tasks. They are dependent on the current complement of equipment components, software versions, security policies, and NRSS operating procedures. Most of the tasks are performed only once per year. The data management staff is expected to determine the best method to use at each

particular invocation. These specific tasks fit in the general management framework, operation of which is detailed in the data management plan's SOP 303 (Johnson and Moynahan 2008). Understanding framework operation is a prerequisite to performing the FQ protocol-specific processes.

The data management web site supports a number of necessary tasks required in accomplishing the staging to production process. These are depicted in Figure SOP 14.1 as rounded rectangles within the data management web server object. Their use is explained in the various SOPs covering detailed creation of data deliverables.

5.0 Literature Cited

Johnson, W. F., and B. J. Moynahan. 2008. Data management plan: Southeast Alaska network. Natural Resource Report NPS/SEAN/NRR—2008/058. National Park Service, Fort Collins, Colorado.

Appendix A. Monitoring site descriptions and directions

Note: Locations from Google Earth WGS84 datum. This table may be updated in the future with more precise GPS locations.

Site Identifier	Site Name	Park Unit	Drainage area (ha)	Approx. bankfull width at site (m)	Latitude (N)	Longitude (W)	Began Operation
IN	Indian River	SITK	3,185	5	57.052797	-135.317486	5/26/2010
SA	Salmon River	GLBA	11,552	7	58.452350	-135.740900	6/5/2010
TA	Taiya River	KLGO	46,361	48	59.511975	-135.346363	4/25/2011

Directions to GLBA monitoring site (created February 2012):

Travel north from Four Corners (Gustavus Dray and Homeshore Pizza) on Wilson Road. Turn left off Wilson Road at the borrow pit/ponds area and drive north along the west side of the two borrow pit ponds to the back pond. Take the old road along the northwest corner of the back pond and travel approx. 0.3 miles north to the next borrow pond. Take another left on the old road along the northwest corner of this second V-shaped, older pond. Follow the old, alder lined road approx. 0.3 miles northwest to the Salmon River. Hike approximately 0.25 miles upstream along the river's left bank (looking downstream) until the NPS boundary markers and associated survey cut transecting the stream are encountered. The sonde installation site is just upstream of the national park boundary.

Directions to KLGO monitoring site (created February 2012):

Travel north out of Skagway on State Street, which will turn into Klondike Highway shortly after leaving town. After approximately one mile after the road turns into Klondike Highway, take a left onto Dyea Road. Follow Dyea Road for approximately 7 miles until you come to the Taiya River Bridge. The sonde is installed just downstream of the bridge on the river left bank.

Directions to SITK monitoring site (created February 2012):

At the Indian River and Sawmill Creek Blvd. (S-933) crossing, head upstream from the overpass along the river right (looking downstream) bank. There is a trail that follows a diversion pipe along this bank. The monitoring site is approximately 50 m from the overpass.

Figure APP B.2. Staging.

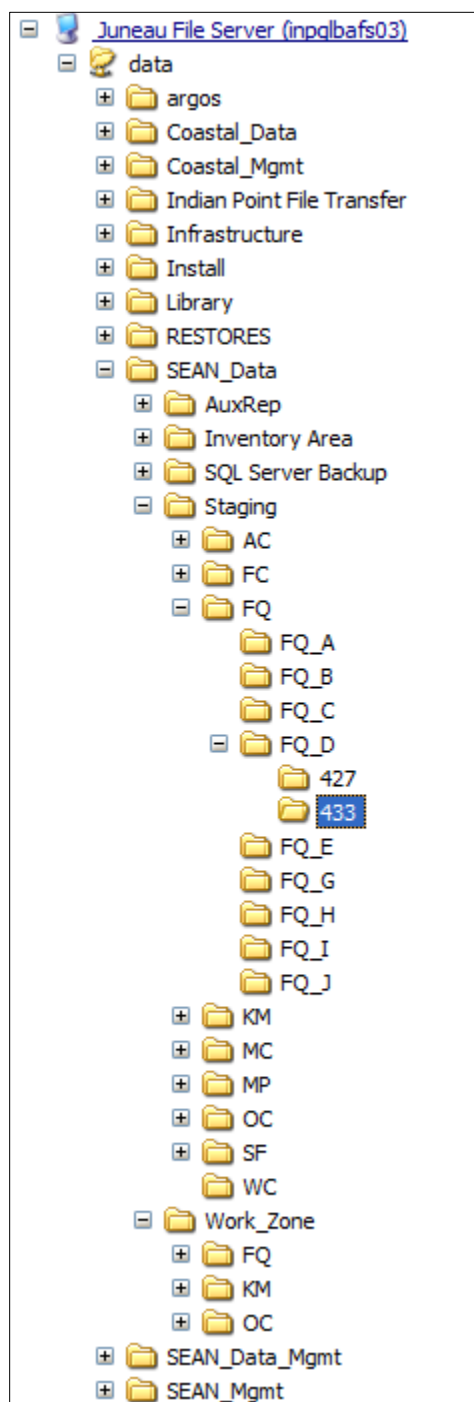
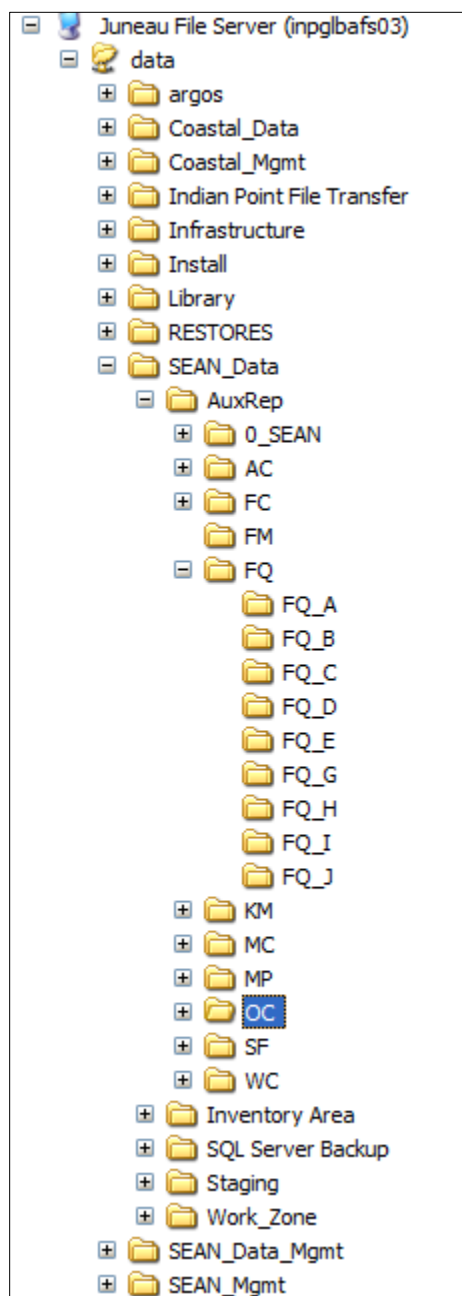


Figure APP B.3. Master auxiliary repository.



Appendix C. Program tracking spreadsheet layout

Deliverables have been defined rigorously, as have the processes required to create them. Because they are of a detailed nature, it is imperative the deliverables be tracked through the workflow to ensure all tasks have been completed. An annual tracking spreadsheet has been created that lists all the required deliverables and milestones that must be met as processing takes place (Figure APP C.1). Whenever a milestone is achieved for the first time for a deliverable, its cell is filled in with the date. Where a milestone does not apply to a particular deliverable, it is permanently designated “na”. As an example, the “FQ_D maintenance log images” deliverable is not appropriate to the “Installed in staging database” milestone. FQ_D are Windows PDF files that reside in the SEAN staging repository on a file server. They are not intended to be stored as database relational tables.

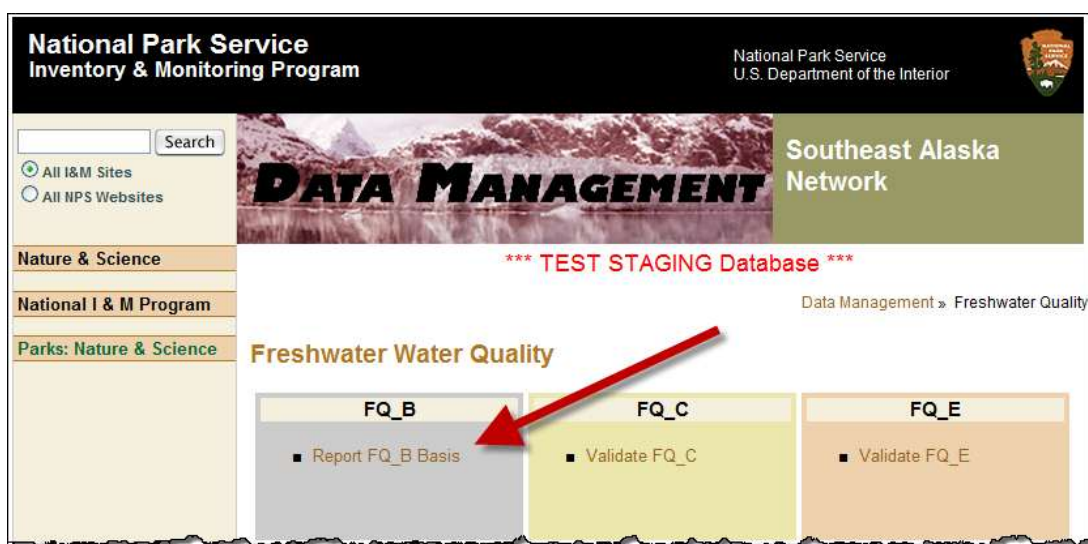


Figure SOP 5.2: Generating the availability report from the FQ_F database from the data management web site.

Southeast Alaska Network Freshwater Water Quality Monitoring Protocol: Version FQ-2013.1


Vital sign: Freshwater Water Quality Monitoring			National Park Service U.S. Department of the Interior 									
Year: 2011			Deliverable									
	Milestone	Responsible Person	FQ_A Protocol	FQ_B Data availability	FQ_C Site visit worksheet	FQ_D Maintenance log images	FQ_E Sonde raw data	FQ_F Database	FQ_G Annual report	FQ_H Five-year report	FG_I NPStore submission	FQ_J Corrected raw data
Development	Protocol review initiated	Program Manager										
	Protocol draft completed	Program Manager										
Acquisition	Field data collection begins	Project Leader										
	Field data collection ends	Project Leader										
	All data received from field	Project Leader										
	All documents received from sonde service	Project Leader										
	Automated deliverable generation complete	Data manager										
	Peer review comments received	Program Manager										
Certification	Peer review response/revisions complete	Program Manager										
	First submission to validation	Project Leader										
	Mandatory validation passed	Data manager										
Repository	Deliverable certified	Project Leader										
	Installed in SEAN staging repository	Data manager										
	Metadata revised in repository	Data manager										
	SEAN staging repository copied to production	Data manager										
	Installed in staging database	Data manager										
	Staging database updates production	Data manager										
	Sent to / accepted by WRD	Data manager										
Dissemination	Sent to / accepted by NPS Data Store	Data manager										
	TEST web links revised	Data manager										
	TEST web links tested	Data manager										
	Web links deployed to production	Data manager										
	Production web links tested	Data manager										

Figure APP C.1. The program tracking grid used to ensure that all data deliverables are complete.

Appendix D. Deliverable definitions

Deliverables are the data and information products that are validated, certified, archived, and disseminated through the Southeast Alaska Network. Scientific deliverables are typically built by the Project Leader and submitted to the Data Manager. A few technical deliverables, which are of an information-management rather than scientific nature, are built by the Data Manager. Regardless of the source, every deliverable is formally validated by the Data Manager and certified by the originator before it is made available.

In order to carry out these processes, it is necessary to define in full detail the content, nature, and domain of each deliverable. Complete definitions also support subsequent interpretation of the products by removing ambiguity.

Appendix D defines every deliverable supported by the SEAN freshwater water quality monitoring program. It follows policies set in the SEAN Data Management Plan (Johnson and Moynahan 2008: SOP 302 – Data Management Considerations in Protocol Development). Using that method, the top level description of a deliverable is explained using a single form named either A, B, C, or D. The specific form used for a particular deliverable depends on the nature of the deliverable's contents. Deliverables of a tabular type are further defined with a form X, where the structure of the table is described. Each individual attribute (i.e., column, field) of a table is then defined in detail using a form Y. Using this set of six forms, all data and information involved in the SEAN freshwater water quality monitoring program (and other SEAN programs) are consistently, precisely, and fully defined.

Each deliverable is also documented with a data flow diagram. These explain exactly where underlying data come from, what processes are applied to them, where the results of processing are stored, and who is responsible for managing each of them.

Contents

	Page
Figures.....	153
D.1 FQ_A: Protocol	154
D.2 FQ_B: Data Availability Matrix	156
D.3 FQ_C: Site Visit Worksheets	158
D.4 FQ_D: Maintenance Log Images	160
D.5 FQ_E: Raw Sonde Data	162
D.6 FQ_F: Cumulative Database	164
D.7 FQ_G: Annual Report.....	187
D.8 FQ_H: Five-Year Report	189
D.9 FQ_I: NPStoret Submission.....	191
D.10 FQ_J: Processed CSV Data.....	193

Figures

	Page
Figure D.1. Data flow required to generate deliverable FQ_A – protocol.	154
Figure D.2. Data flow required to generate deliverable FQ_B – data availability matrix.	156
Figure D.3. Data flow required to generate deliverable FQ_C – site visit worksheet.	158
Figure D.4. Data flow required to generate deliverable FQ_D - maintenance log images.	160
Figure D.5. Data flow required to generate deliverable FQ_E – raw sonde data.	162
Figure D.6. Data flow required to generate deliverable FQ_F – cumulative database.	164
Figure D.7. Data flow required to generate deliverable FQ_G – annual report.	187
Figure D.7. Data flow required to generate deliverable FQ_H – five-year report.	189
Figure D.9. Data flow required to generate deliverable FQ_I – NPStoret submission.	191
Figure D.10. Data flow required to generate deliverable FQ_J – CSV files.	193

Deliverable definition forms:**Form A: Non-Tabular Information Deliverable**

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Deliverable ID:</i> FQ_A	<i>Deliverable Title:</i> Protocol
<i>File format:</i> DOCX and PDF	<i>Associated software and version:</i> Word 2010 + Adobe Acrobat 9 pro	<i>Revision Date / protocol version:</i> 08-30-2011 / FQ-2013.1
<i>Expected frequency:</i> unknown	<i>Likely dissemination partners:</i> None – served by SEAN	<i>Submission unit:</i> N/A: a single unit to supplant the existing FQ_A.
<i>What purpose does this deliverable serve?</i> Defines the technical methodology employed in the SEAN freshwater water quality monitoring program.		
<i>Summary of content:</i> Narrative, detailed appendices, standard operating procedures for conducting program. A PDF copy is kept for dissemination purposes. A DOCX copy is kept as the basis for the next version update.		
<i>Mandatory validation criteria:</i> 1. PDF must successfully open using Adobe Reader 9.0 or greater. 2. DOCX must successfully open using Microsoft Word 2010. 3. Must consistently reference a correct version number, as defined in SEAN Data Management Plan (Johnson and Moynahan 2008: SOP 602 – Version Control).		
<i>Optional validation criteria:</i> - None -		
<i>Deliverable ID of any other SEAN data products required to create this product</i> Most recent prior FQ_A.		
<i>Description and source of any outside data required to create this product:</i> No specific sources can be named in advance. Editors will have to draw on a number of areas of technical expertise and guidance to complete this deliverable.		

D.2 FQ_B: Data Availability Matrix

Purpose of deliverable: Researchers need to be informed of the availability of specific data by location and year. Specific data collected varies depending on factors such as the type of detectors installed at the time, weather conditions, and field circumstances. The availability depicted here is derived from the presence of time and type entries existing based in deliverable FQ_F cumulative database. “Type” granularity refers to the type of physical parameter measured: temperature, pH, etc. If the data management procedures are strictly observed, then the matrix will inherently also reflect availability of FQ_F’s precursors: FQ_C and FQ_J.

Frequency produced: This must always be performed directly after completing a deliverable FQ_F cumulative database, which is normally done annually. The actual deliverable disseminated for FQ_B is a PDF file. However, an Excel spreadsheet is also part of this deliverable, though not served on the web site. The spreadsheet serves as the source for the PDF and the basis for the next update.

Prerequisites: FQ_F cumulative database.

Data flow:

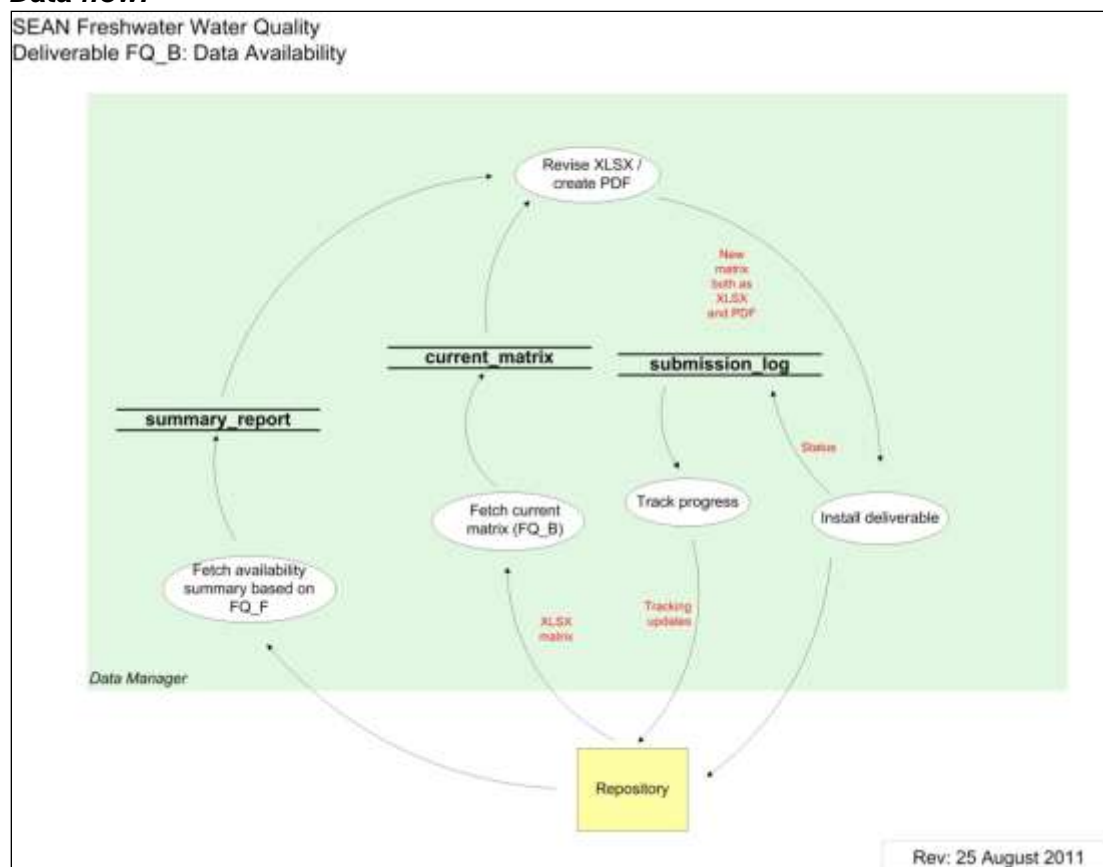


Figure D.2. Data flow required to generate deliverable FQ_B – data availability matrix.

D.3 FQ_C: Site Visit Worksheets

Purpose of deliverable: During the continuous data collection season, each sonde is visited monthly to assess its condition and calibration. Observations from each monthly visit are recorded on a formal fixed-content, fixed-format spreadsheet. These are subsequently used to alter segments of the processed data (FQ_J) to adjust values to account for individual sensor drift, anomaly, and/or failure. The site visit worksheet is also used to assign quality flags to the data within its scope.

Frequency produced: One site visit worksheet is produced at for every sonde each month (or partial month) it is actively collecting data. At the end of the continuous monitoring period for the year, all worksheets from all sites for that year are zipped into a single file for archiving and dissemination as a package.

Prerequisites: None.

Data flow:

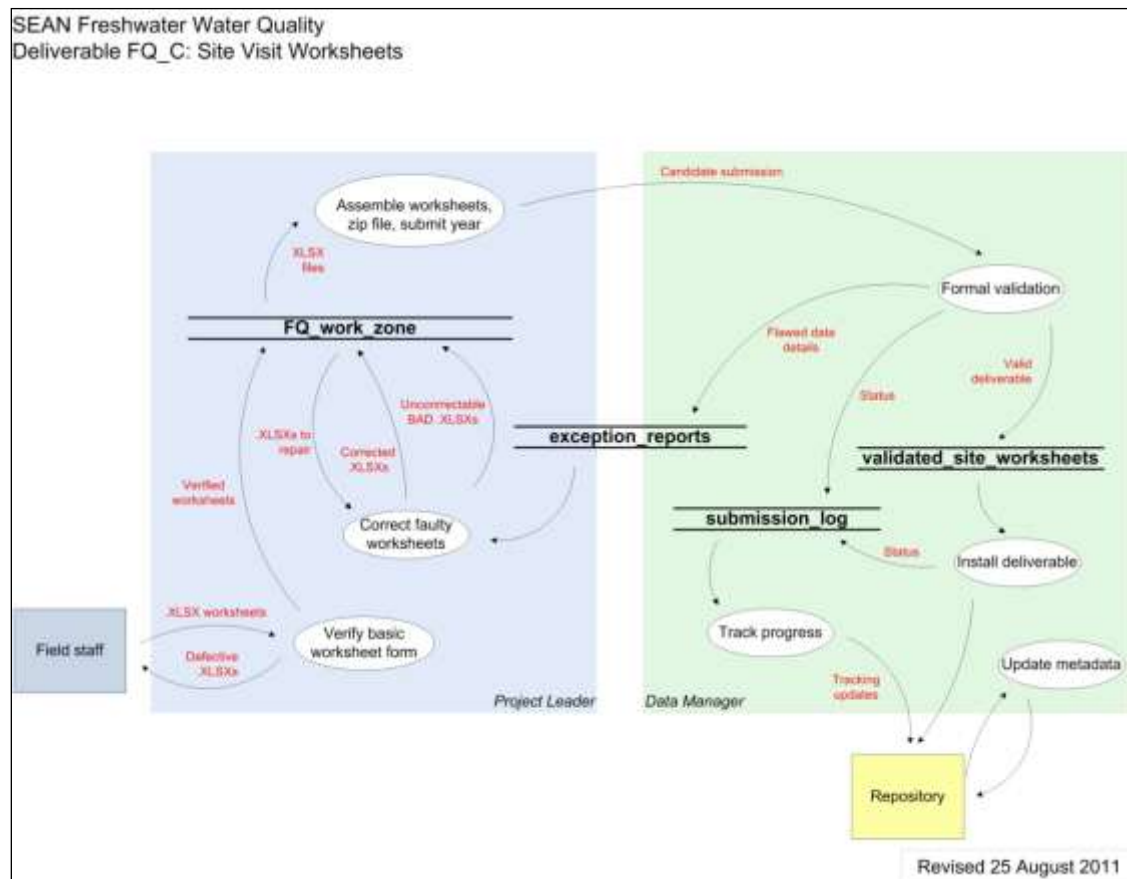


Figure D.3. Data flow required to generate deliverable FQ_C – site visit worksheet.

Deliverable definition forms:**Form C: Non-Tabular Data Deliverable**

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Deliverable ID:</i> FQ_C	<i>Deliverable Title:</i> Site visit worksheets
<i>File format:</i> XLSX packaged as ZIP	<i>Associated software and version:</i> MS Excel 2010 or later	<i>Revision Date / protocol version:</i> 08-30-2011 / FQ-2013.1
<i>Expected frequency:</i> 1/year	<i>Likely dissemination partners:</i> None – served by SEAN	<i>Submission unit:</i> Year
<i>What purpose does this deliverable serve?</i> Documents the condition and calibration levels of a sonde and its sensors during the continuous monitoring season.		
<i>Summary of content:</i> A fixed-format containing date of visit, operator, site, sonde serial#, comments regarding sonde integrity, battery replacement record, calibration values for all sensors, and documentation of any field recalibrations performed. The file naming convention for each sheet is: FQ_C_4-letter park code_2-letter site code_site_visit_date-as-YYYYMMDD.xlsx. For example: FQ_C_SITK_IN_SITE_VISIT_20100604.XLSX. Details regarding the form, content, and naming of the worksheet are specified in SOP 1.		
<i>Mandatory validation criteria:</i> 1. Must be able to be opened successfully using Microsoft Excel 2010 or later. 2. Fixed content, layout, and format must not be materially altered from the standard form set for the collection year.		
<i>Optional validation criteria:</i> - None -		
<i>Deliverable ID of any other SEAN data products required to create this product:</i> - None -		
<i>Description and source of any outside data required to create this product:</i> - None -		

D.4 FQ_D: Maintenance Log Images

Purpose of deliverable: Sonde sensors are periodically given preventative maintenance, repairs, and calibration certification. Each sonde unit is generally serviced annually, though special circumstances may require units to be repaired *ad hoc*. When a unit is returned to the Project Leader from the service contractor, it is accompanied by certificates specifying the maintenance performed and attesting to their accuracy. Researchers need to find these in order to troubleshoot questionable readings from the instruments.

Frequency produced: Whenever any servicing results are reported to the Project Leader, certificates are provided as paper forms. These are filed until the end of the year at which time they are scanned into PDFs, zipped into a single package, and disseminated.

Prerequisites: None.

Data flow:

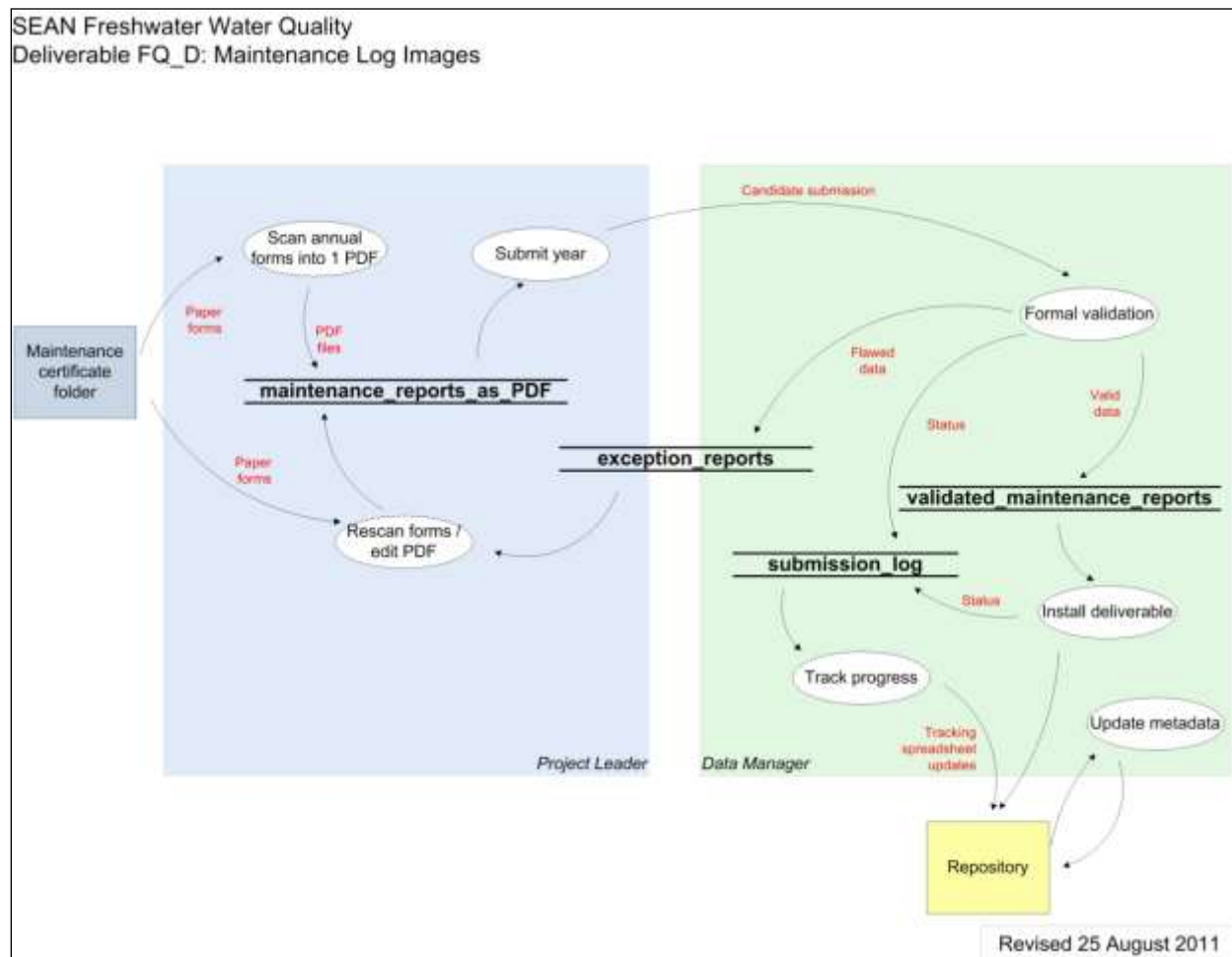


Figure D.4. Data flow required to generate deliverable FQ_D - maintenance log images.

Deliverable definition forms:

Form C: Non-Tabular Data Deliverable

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Deliverable ID:</i> FQ_D	<i>Deliverable Title:</i> Maintenance log images
<i>File format:</i> PDF	<i>Associated software and version:</i> Adobe Acrobat 9 pro	<i>Revision Date / protocol version:</i> 08-30-2011 / FQ-2013.1
<i>Expected frequency:</i> 1/year	<i>Likely dissemination partners:</i> None – served by SEAN	<i>Submission unit:</i> Year
<i>What purpose does this deliverable serve?</i> Source documents may be used for researching data errors and individual exceptions.		
<i>Summary of content:</i> Two-sided color scanned images of field log sheets.		
<i>Mandatory validation criteria:</i> 1. Must successfully open using Adobe Reader 9.0 or greater. 2. Filename must conform to submission unit pattern described in detailed steps.		
<i>Optional validation criteria:</i> 1. Images should be as clearly legible as the original paper forms.		
<i>Deliverable ID of any other SEAN data products required to create this product</i> - None -		
<i>Description and source of any outside data required to create this product:</i> Paper certificates and maintenance forms from outside contractor.		

D.5 FQ_E: Raw Sonde Data

Purpose of deliverable: During the continuous data collection season, sondes are set to capture observations hourly. The data accumulate in the device and are not erased until after the season has been completely processed. Periodically, the data in sondes are captured in data “.DAT” files proprietary to YSI, Inc. These files form the basis of the Processed CSV (FQ_J) deliverable, which then is the basis for the Cumulative Database (FQ_F). Normally, only the final file from a site is of interest. However, all interim files are retained in case data recovery is required due to instrument loss or catastrophic failure later in the season.

Frequency produced: One cumulative copy of the season’s sonde data is captured each month (or partial month) that data are actively being collected. At the end of the continuous monitoring period for the year, all worksheets from all sites for that year are zipped into a single file for archiving and dissemination as a package.

Prerequisites: None.

Data flow:

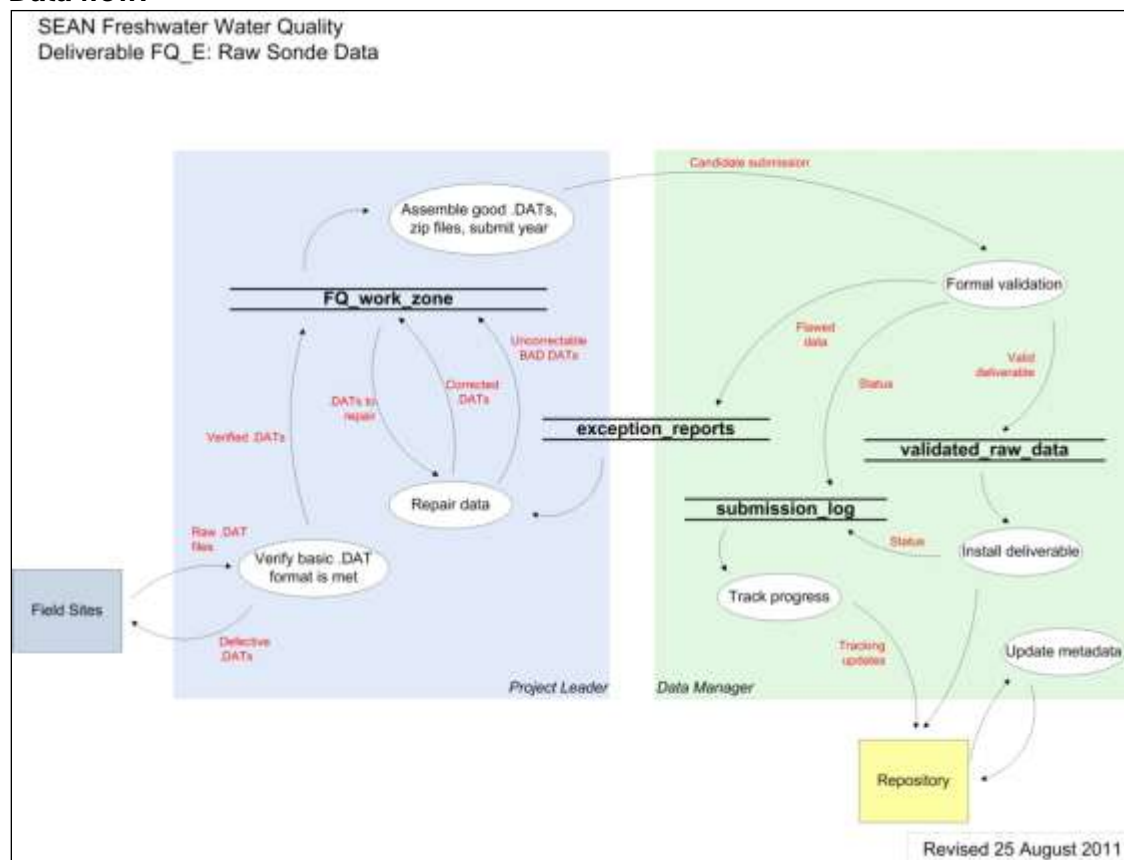


Figure D.5. Data flow required to generate deliverable FQ_E – raw sonde data.

Deliverable definition forms:

Form C: Non-Tabular Data Deliverable

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Deliverable ID:</i> FQ_E	<i>Deliverable Title:</i> Raw sonde data
<i>File format:</i> .DAT files packaged as ZIP	<i>Associated software and version:</i> YSI EcoWatch 3.18 or later	<i>Revision Date / protocol version:</i> 08-31-2011 / FQ-2013.1
<i>Expected frequency:</i> 1/year	<i>Likely dissemination partners:</i> NPS IRMA, EPA Storet	<i>Submission unit:</i> Year
<i>What purpose does this deliverable serve?</i> The collection of cumulative data files captured from deployed sondes.		
<i>Summary of content:</i> Proprietary .DAT files packaged together into one ZIP file for each particular year. This is the basis for the FQ_J deliverable. The naming convention for each individual data file is: FQ_E_4-letter park code_2-letter site code_site_visit_date-as-YYYYMMDD.DAT, as specified in SOP 3. For example: FQ_C_SITK_IN_SITE_VISIT_20100604.DAT. The naming for the final deliverable file is FQ_E_yyyy.ZIP, where “yyyy” is the year covered.		
<i>Mandatory validation criteria:</i> 1. The zip file must successfully expand with software commonly used for the purpose, such as WINZIP. 2. Once unzipped, each component must be able to be successfully opened using YSI EcoWatch version 3.18 or later.		
<i>Optional validation criteria:</i> None.		
<i>Deliverable ID of any other SEAN data products required to create this product:</i> None.		
<i>Description and source of any outside data required to create this product:</i> None.		

D.6 FQ_F: Cumulative Database

Purpose of deliverable: A freshwater water quality database is maintained that contains all instrument readings collected by the program over all sites and years. The database is updated from underlying FQ_J CSV data files. Database rows may differ slightly from original FQ_E raw data in having data quality information, outlier identification, etc. Through the web, the database may be queried to produce a single file on the customer's workstation containing final data, filtered to meet the customer's particular area of interest. This is used, among other things, to inform the Annual Report (FQ_G) and 5-Year Report (FQ_H), and to produce repository files for applications such as IRMA.

FQ_F has no optional validation criteria. Quality has already been enforced during creation of the FQ_J CSV files.

Frequency produced: FQ_F is generated from FQ_J by a custom application at the end of each season directly after certification of FQ_J processed CSV files.

Prerequisites: Production of this deliverable is dependent on having a certified FQ_J product for the year.

Data flow:

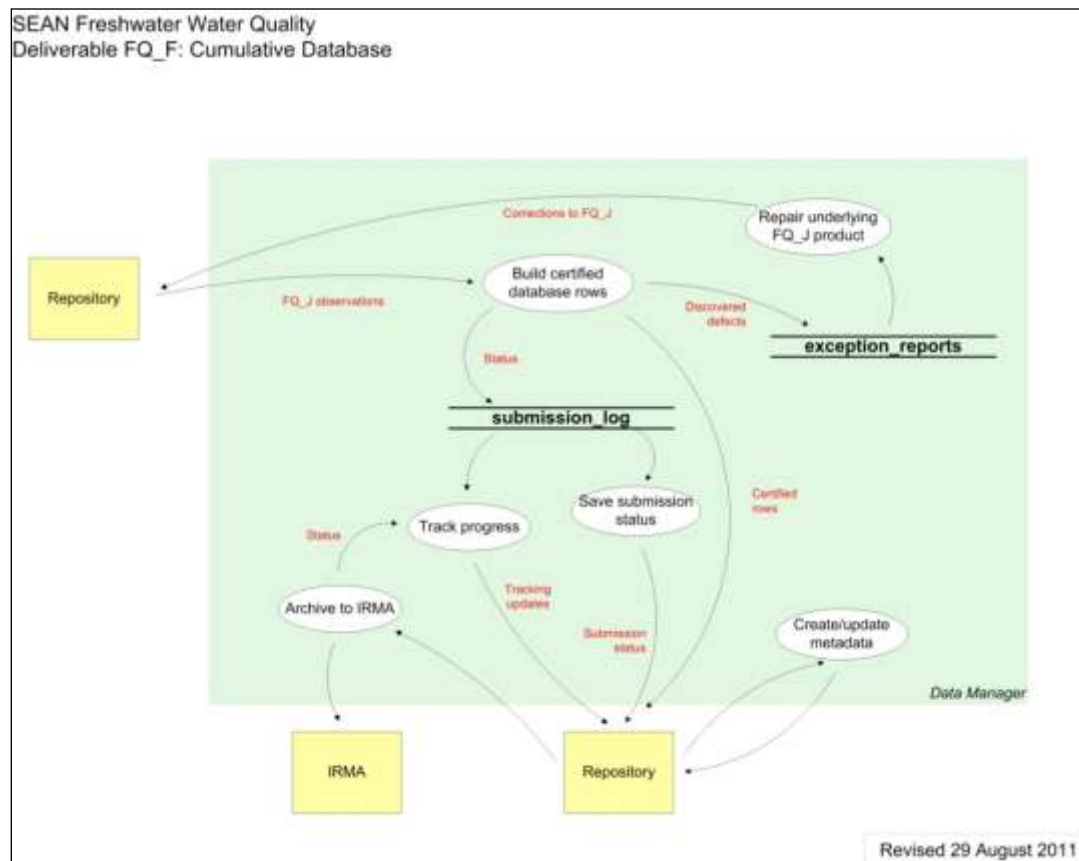


Figure D.6. Data flow required to generate deliverable FQ_F – cumulative database.

Deliverable definition forms:

Form D: Tabular Data Deliverable

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Deliverable ID:</i> FQ_F	<i>Deliverable Title:</i> Cumulative database
<i>File format:</i> n/a	<i>Associated software and version:</i> n/a	<i>Revision Date / protocol version:</i> 08-31-2011 / FQ-2013.1
<i>Expected frequency:</i> 1 submission/year	<i>Likely dissemination partners:</i> None – served by SEAN	<i>Submission unit:</i> YEAR
<i>What purpose does this deliverable serve?</i> Provides a cumulative database of all sensor readings taken during the SEAN freshwater water quality monitoring program.		
<i>Identifiers of relations that compose the tabular deliverable (“Relations” are tables or files that provide information which may be represented in a grid format. Each relation listed must be fully defined in its own accompanying Form X.):</i> tbl_fq_readings		
<i>Deliverable ID of any other SEAN data products required to create this product:</i> FQ_J		
<i>Description and source of any outside data required to create this product:</i> - none -		

Form X: Relation Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Relation identifier:</i> tbl_fq_readings	<i>Used by deliverable ID:</i> FQ_F																																								
<i>Revision Date / protocol version:</i> 12-202011 / FQ-2013.1	<i>Type of relation:</i> Database Table	<i>Estimated rows:</i> 300,000+																																								
<i>Natural primary key for this relation:</i> date_local + time_local + site																																										
<i>Purpose:</i> Freshwater water quality instrument readings taken at periodic intervals in multiple locations. The table appears totally denormalized to facilitate web downloading and direct use by Excel and MS Access.																																										
<i>Identifiers of attributes defined over this relation (“Attributes” are columns of the grid. Each attribute must be defined in an accompanying Form Y.):</i> <table border="1"> <tr><td>DATE_LOCAL</td><td>TIME_LOCAL</td></tr> <tr><td>PARK</td><td>SITE</td></tr> <tr><td>LATITUDE</td><td>LONGITUDE</td></tr> <tr><td>SONDE_SN</td><td>RECORDER</td></tr> <tr><td>TEMPERATURE</td><td>TEMP_RECORD_QUALITY</td></tr> <tr><td>TEMP_DATA_GRADE</td><td>TEMP_OUTLIER</td></tr> <tr><td>TEMP_QUALITY_COMMENT</td><td>CONDUCTIVITY</td></tr> <tr><td>COND_RECORD_QUALITY</td><td>COND_DATA_GRADE</td></tr> <tr><td>COND_OUTLIER</td><td>COND_QUALITY_COMMENT</td></tr> <tr><td>PH</td><td>PH_RECORD_QUALITY</td></tr> <tr><td>PH_DATA_GRADE</td><td>PH_OUTLIER</td></tr> <tr><td>PH_QUALITY_COMMENT</td><td>DO_CONCENTRATION</td></tr> <tr><td>DO_RECORD_QUALITY</td><td>DO_DATA_GRADE</td></tr> <tr><td>DO_OUTLIER</td><td>DO_QUALITY_COMMENT</td></tr> <tr><td>TURBIDITY</td><td>TURB_RECORD_QUALITY</td></tr> <tr><td>TURB_DATA_GRADE</td><td>TURB_OUTLIER</td></tr> <tr><td>TURB_QUALITY_COMMENT</td><td>DO_PERCENT</td></tr> <tr><td>PROTOCOL_ID</td><td>SUBMISSION_NUMBER</td></tr> <tr><td>USERID</td><td>TIME_STAMP</td></tr> <tr><td>COMMENTS</td><td></td></tr> </table>			DATE_LOCAL	TIME_LOCAL	PARK	SITE	LATITUDE	LONGITUDE	SONDE_SN	RECORDER	TEMPERATURE	TEMP_RECORD_QUALITY	TEMP_DATA_GRADE	TEMP_OUTLIER	TEMP_QUALITY_COMMENT	CONDUCTIVITY	COND_RECORD_QUALITY	COND_DATA_GRADE	COND_OUTLIER	COND_QUALITY_COMMENT	PH	PH_RECORD_QUALITY	PH_DATA_GRADE	PH_OUTLIER	PH_QUALITY_COMMENT	DO_CONCENTRATION	DO_RECORD_QUALITY	DO_DATA_GRADE	DO_OUTLIER	DO_QUALITY_COMMENT	TURBIDITY	TURB_RECORD_QUALITY	TURB_DATA_GRADE	TURB_OUTLIER	TURB_QUALITY_COMMENT	DO_PERCENT	PROTOCOL_ID	SUBMISSION_NUMBER	USERID	TIME_STAMP	COMMENTS	
DATE_LOCAL	TIME_LOCAL																																									
PARK	SITE																																									
LATITUDE	LONGITUDE																																									
SONDE_SN	RECORDER																																									
TEMPERATURE	TEMP_RECORD_QUALITY																																									
TEMP_DATA_GRADE	TEMP_OUTLIER																																									
TEMP_QUALITY_COMMENT	CONDUCTIVITY																																									
COND_RECORD_QUALITY	COND_DATA_GRADE																																									
COND_OUTLIER	COND_QUALITY_COMMENT																																									
PH	PH_RECORD_QUALITY																																									
PH_DATA_GRADE	PH_OUTLIER																																									
PH_QUALITY_COMMENT	DO_CONCENTRATION																																									
DO_RECORD_QUALITY	DO_DATA_GRADE																																									
DO_OUTLIER	DO_QUALITY_COMMENT																																									
TURBIDITY	TURB_RECORD_QUALITY																																									
TURB_DATA_GRADE	TURB_OUTLIER																																									
TURB_QUALITY_COMMENT	DO_PERCENT																																									
PROTOCOL_ID	SUBMISSION_NUMBER																																									
USERID	TIME_STAMP																																									
COMMENTS																																										
<i>Mandatory validation criteria involving multiple attributes:</i> - none -																																										
<i>Optional validation criteria involving multiple attributes:</i> - none -																																										

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DATE_LOCAL	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 08-31-2011 / FQ-2013.1	<i>Default report heading:</i> DATE	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> The date a particular set of readings were recorded. Time zone is always GMT-8, which corresponds to Alaska Daylight Time.		
<i>Data type:</i>	date	
<i>Maximum length</i>	n/a	
<i>Required:</i>	yes	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must be a valid date. 2. Must not be a date beyond the current one at point of validation. 3. Must not be a date before 2010.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TIME_LOCAL	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 08-31-2011 / FQ-2013.1	<i>Default report heading:</i> TIME	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> The time a particular set of readings were recorded. Time zone is always GMT-8, which corresponds to Alaska Daylight Time.		
<i>Data type:</i>	time	
<i>Maximum length</i>	n/a	
<i>Required:</i>	yes	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must be a valid time.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PARK	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 08-31-2011 / FQ-2013.1	<i>Default report heading:</i> PARK	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> The NPS unit ID for the park in which the observation site is located.		
<i>Data type:</i>	Varchar(4)	
<i>Maximum length</i>	4	
<i>Required:</i>	yes	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must be one of GLBA, KLGO, SITK.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> SITE	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 08-31-2011 / FQ-2013.1	<i>Default report heading:</i> SITE	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> The coded site where the sonde was located when the readings were recorded.		
<i>Data type:</i>	Varchar(4)	
<i>Maximum length</i>	4	
<i>Required:</i>	yes	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	any	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must be one of IN, SA, TA.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> LATITUDE	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 12-20-2011 / FQ-2013.1	<i>Default report heading:</i> LATITUDE	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Decimal latitude using the WGS84 datum.		
<i>Data type:</i>	real	
<i>Maximum length</i>	8	
<i>Required:</i>	no	
<i>Measurement units:</i>	degrees	
<i>Format:</i>	99.99999	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must be a real number.	
<i>Optional validation rules for this attribute:</i>	Should be between 57.0 and 61.0	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> LONGITUDE	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 12-20-2011 / FQ-2013.1	<i>Default report heading:</i> LONGITUDE	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Decimal longitude using the WGS84 datum.		
<i>Data type:</i>	real	
<i>Maximum length</i>	10	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	-999.99999	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must be a real number.	
<i>Optional validation rules for this attribute:</i>	Should be between -135.0 and -142.0.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> SONDE_SN	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 08-31-2011 / FQ-2013.1	<i>Default report heading:</i> SONDE SERIAL#	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Uniquely identifies the sonde used for particular readings. The manufacturer's serial number is used for this purpose.		
<i>Data type:</i>	Varchar(32)	
<i>Maximum length</i>	32	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must not exceed maximum length.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> RECORDER	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 08-31-2011 / FQ-2013.1	<i>Default report heading:</i> RECORDER	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Name of the field person who collected the particular raw data file this row is based on.		
<i>Data type:</i>	Varchar(32)	
<i>Maximum length</i>	32	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must not exceed maximum length.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TEMPERATURE	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-16-2011 / FQ-2013.1	<i>Default report heading:</i> Temperature (°C)	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Water temperature in degrees Celsius as reported by sonde.		
<i>Data type:</i>	Real	
<i>Maximum length</i>	6	
<i>Required:</i>	no	
<i>Measurement units:</i>	Degrees C	
<i>Format:</i>	99.999	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must be a real number < 100.0.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TEMP_RECORD_QUALITY	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 12-20-2011 / FQ-2013.1	<i>Default report heading:</i> Temperature Record Quality	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Indicator of the quality of the temperature observation, for determining whether to include it in analyses: 0=good (the default), 1=unknown (no site visit sheet), 2=questionable (inconsistent sensor readings, exception noted on log sheet), 3=bad (dead sensor, failing battery, scrambled DAT file, sonde physically damaged, washout, sonde out of water).		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match 0, 1, 2, or 3.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TEMP_DATA_GRADE	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Temperature Data Grade	tbl_fq_readings
<i>Purpose:</i> A code signifying data grade based on the criteria detailed in SOP 2. E=excellent, G=good, F=fair, P=poor. It is only present when TEMP_RECORD_QUALITY = 0.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match E, G, F, or P. 2. Must be present if and only if TEMP_RECORD_QUALITY=0.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TEMP_OUTLIER	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Temperature Outlier	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Assigned the value 'Y' if and only if the Project Leader judges TEMPERATURE to be a data outlier.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	Upper	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must be 'Y'.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TEMP_QUALITY_COMM ENT	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Temperature Comment	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Explanation of why record quality for temperature was not considered “good.”		
<i>Data type:</i>	Varchar(512)	
<i>Maximum length</i>	512	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	- none -	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> CONDUCTIVITY	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Conductivity (mS/cm)	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Conductivity in milliSiemens/centimeter as reported by sonde.		
<i>Data type:</i>	Real	
<i>Maximum length</i>	6	
<i>Required:</i>	no	
<i>Measurement units:</i>	mSiemens/cm	
<i>Format:</i>	9.9999	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	2. Must be a real number between 0.0 and 9.9999.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> COND_RECORD_QUALITY	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 12-20-2011 / FQ-2013.1	<i>Default report heading:</i> Conductivity Record Quality	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Indicator of the quality of the conductivity observation, for determining whether to include it in analyses: 0=good (the default), 1=unknown (no site visit sheet), 2=questionable (inconsistent sensor readings, exception noted on log sheet), 3=bad (dead sensor, failing battery, scrambled DAT file, sonde physically damaged, washout, sonde out of water).		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match 0, 1, 2, or 3.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> COND_DATA_GRADE	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Conductivity Data Grade	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> A code signifying data grade based on the criteria detailed in SOP 2. E=excellent, G=good, F=fair, P=poor. It is only present when COND_RECORD_QUALITY = 0.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match E, G, F, or P. 2. Must be present if and only if COND_RECORD_QUALITY=0.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> COND_OUTLIER	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Conductivity Outlier	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Assigned the value 'Y' if and only if the Project Leader judges CONDUCTIVITY to be a data outlier.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	Upper	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must be 'Y'.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> COND_QUALITY_COMMENT	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Conductivity Comment	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Explanation of why record quality for conductivity was not considered "good."		
<i>Data type:</i>	Varchar(512)	
<i>Maximum length</i>	512	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	- none -	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PH	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> pH	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> pH of water as reported by sonde.		
<i>Data type:</i>	Real	
<i>Maximum length</i>	6	
<i>Required:</i>	no	
<i>Measurement units:</i>	pH units	
<i>Format:</i>	99.000	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	3. Must be a real number between 1.0 and 12.0.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PH_RECORD_QUALITY	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 12-20-2011 / FQ-2013.1	<i>Default report heading:</i> pH Record Quality	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Indicator of the quality of the pH observation, for determining whether to include it in analyses: 0=good (the default), 1=unknown (no site visit sheet), 2=questionable (inconsistent sensor readings, exception noted on log sheet), 3=bad (dead sensor, failing battery, scrambled DAT file, sonde physically damaged, washout, sonde out of water).		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match 0, 1, 2, or 3.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PH_DATA_GRADE	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> pH Data Grade	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> A code signifying data grade based on the criteria detailed in SOP 2. E=excellent, G=good, F=fair, P=poor. It is only present when PH_RECORD_QUALITY = 0.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match E, G, F, or P. 2. Must be present if and only if PH_RECORD_QUALITY=0.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PH_OUTLIER	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> pH Outlier	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Assigned the value 'Y' if and only if the Project Leader judges PH to be a data outlier.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	Upper	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must be 'Y'.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PH_QUALITY_COMMENT	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> pH Comment	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Explanation of why record quality for pH was not considered “good.”		
<i>Data type:</i>	Varchar(512)	
<i>Maximum length</i>	512	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	- none -	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DO_CONCENTRATION	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 03-20-2013 / FQ-2013.1	<i>Default report heading:</i> Dissolved Oxygen	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Dissolved oxygen concentration in milligrams per liter as reported by sonde. Due to instrument precision combined with the possibility of calibration drift, the mandatory minimum value is set less than zero.		
<i>Data type:</i>	Real	
<i>Maximum length</i>	6	
<i>Required:</i>	no	
<i>Measurement units:</i>	Mg/L	
<i>Format:</i>	99.999	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	4. Must be a real number between -2.0 and 99.999.	
<i>Optional validation rules for this attribute:</i>	5. Should be a real number between 0.0 and 99.999.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DO_RECORD_QUALITY	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 12-20-2011 / FQ-2013.1	<i>Default report heading:</i> Oxygen Concentration Quality	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Indicator of the quality of the DO observation, for determining whether to include it in analyses: 0=good (the default), 1=unknown (no site visit sheet), 2=questionable (inconsistent sensor readings, exception noted on log sheet), 3=bad (dead sensor, failing battery, scrambled DAT file, sonde physically damaged, washout, sonde out of water).		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match 0, 1, 2, or 3.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DO_DATA_GRADE	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Oxygen Data Grade	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> A code signifying data grade based on the criteria detailed in SOP 2. E=excellent, G=good, F=fair, P=poor. It is only present when DO_RECORD_QUALITY = 0.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match E, G, F, or P. 2. Must be present if and only if DO_RECORD_QUALITY=0.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DO_OUTLIER	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Oxygen Outlier	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Assigned the value ‘Y’ if and only if the Project Leader judges DO_CONCENTRATION to be a data outlier.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	Upper	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must be ‘Y’.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DO_QUALITY_COMMENT	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Oxygen Comment	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Explanation of why record quality for pH was not considered “good.”		
<i>Data type:</i>	Varchar(512)	
<i>Maximum length</i>	512	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	- none -	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TURBIDITY	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 03-20-2013 / FQ-2013.1	<i>Default report heading:</i> Turbidity (NTU)	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Relative measure of suspended solids expressed in NTUs as reported by sonde. Due to instrument precision combined with the possibility of calibration drift, the mandatory minimum value is set less than zero.		
<i>Data type:</i>	Real	
<i>Maximum length</i>	6	
<i>Required:</i>	no	
<i>Measurement units:</i>	NTU	
<i>Format:</i>	999.99	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	6. Must be a real number. 7. Must be between -2.0 and 999.99.	
<i>Optional validation rules for this attribute:</i>	8. Should be between 0.0 and 999.99.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TURB_RECORD_QUALITY	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 12-20-2011 / FQ-2013.1	<i>Default report heading:</i> Turbidity Quality	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Indicator of the quality of the TURBIDITY observation, for determining whether to include it in analyses: 0=good (the default), 1=unknown (no site visit sheet), 2=questionable (inconsistent sensor readings, exception noted on log sheet), 3=bad (dead sensor, failing battery, scrambled DAT file, sonde physically damaged, washout, sonde out of water).		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match 0, 1, 2, or 3.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TURB_DATA_GRADE	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Turbidity Data Grade	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> A code signifying data grade based on the criteria detailed in SOP 2. E=excellent, G=good, F=fair, P=poor. It is only present when TURB_RECORD_QUALITY = 0.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match E, G, F, or P. 2. Must be present if and only if TURB_RECORD_QUALITY=0.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TURB_OUTLIER	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Turbidity Outlier	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Assigned the value 'Y' if and only if the Project Leader judges TURBIDITY to be a data outlier.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	Upper	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must be 'Y'.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TURB_QUALITY_COMMENT	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Turbidity Comment	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Explanation of why record quality for turbidity was not considered “good.”		
<i>Data type:</i>	Varchar(512)	
<i>Maximum length</i>	512	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	- none -	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DO_PERCENT	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 03-20-2013 / FQ-2013.1	<i>Default report heading:</i> Oxygen Saturation (%)	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Dissolved oxygen saturation percent as calculated and reported by the sonde. Due to instrument precision combined with the possibility of calibration drift, the mandatory minimum value is set less than zero.		
<i>Data type:</i>	Real	
<i>Maximum length</i>	7	
<i>Required:</i>	no	
<i>Measurement units:</i>	%	
<i>Format:</i>	999.999	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	9. Must be a real number. 10. Must be between 0.0 and 130.0.	
<i>Optional validation rules for this attribute:</i>	1. Should be between -2.0 and 130.0.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PROTOCOL_ID	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 08-31-2011 / FQ-2013.1	<i>Default report heading:</i> Protocol	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> The formal version of the protocol under which this row was created.		
<i>Data type:</i>	Varchar(10)	
<i>Maximum length</i>	10	
<i>Required:</i>	yes	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	Tbl_protocol	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must match a protocol in tbl_protocol.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> SUBMISSION_NUMBER	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 08-31-2011 / FQ-2013.1	<i>Default report heading:</i> Submission#	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> The submission number generated by the network data manager for identifying the files from which this particular row came. It is used for several data management purposes, including auditing.		
<i>Data type:</i>	Int32	
<i>Maximum length</i>	n/a	
<i>Required:</i>	yes	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	tbl_submission_log	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	11. Must match a submission_number in tbl_submission_log.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> USERID	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 08-31-2011 / FQ-2013.1	<i>Default report heading:</i> Updated by	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> The login name used to authorize the process that created/updated this row in the cumulative database. It is restricted to those userids stored in the database table called tbl_submitter. It is used for auditing purposes.		
<i>Data type:</i>	Varchar(20)	
<i>Maximum length</i>	20	
<i>Required:</i>	yes	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	tbl_submitter	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must match a user in tbl_submitter.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TIME_STAMP	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 08-31-2011 / FQ-2013.1	<i>Default report heading:</i> Last Updated	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> The date and time this row was most recently inserted or updated in the table. It is used for auditing purposes.		
<i>Data type:</i>	datetime	
<i>Maximum length</i>	n/a	
<i>Required:</i>	yes	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	- none -	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> COMMENTS	<i>Used by deliverable ID:</i> FQ_F
<i>Revision date / protocol version:</i> 08-31-2011 / FQ-2013.1	<i>Default report heading:</i> Comments	<i>Relation (from Form X):</i> tbl_fq_readings
<i>Purpose:</i> Recorded comments regarding circumstances of a particular set of contemporaneous observations.		
<i>Data type:</i>	Varchar(1024)	
<i>Maximum length</i>	1024	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	Must not exceed maximum length.	
<i>Optional validation rules for this attribute:</i>	- none -	

D.7 FQ_G: Annual Report

Purpose of deliverable: This is a report that summarizes the operations and outcomes of a season. Content includes list of spatial/temporal coverage, tables and plots illustrating current conditions, operation exceptions, and notification of any changes to the protocol. The content is appropriate for an audience of management as well as for the public. It is built in the form of an NPS NRR report.

Frequency produced: These are typically created annually, after completion of each field season.

Prerequisites: Certified database deliverable FQ_F for the season.

Data flow:

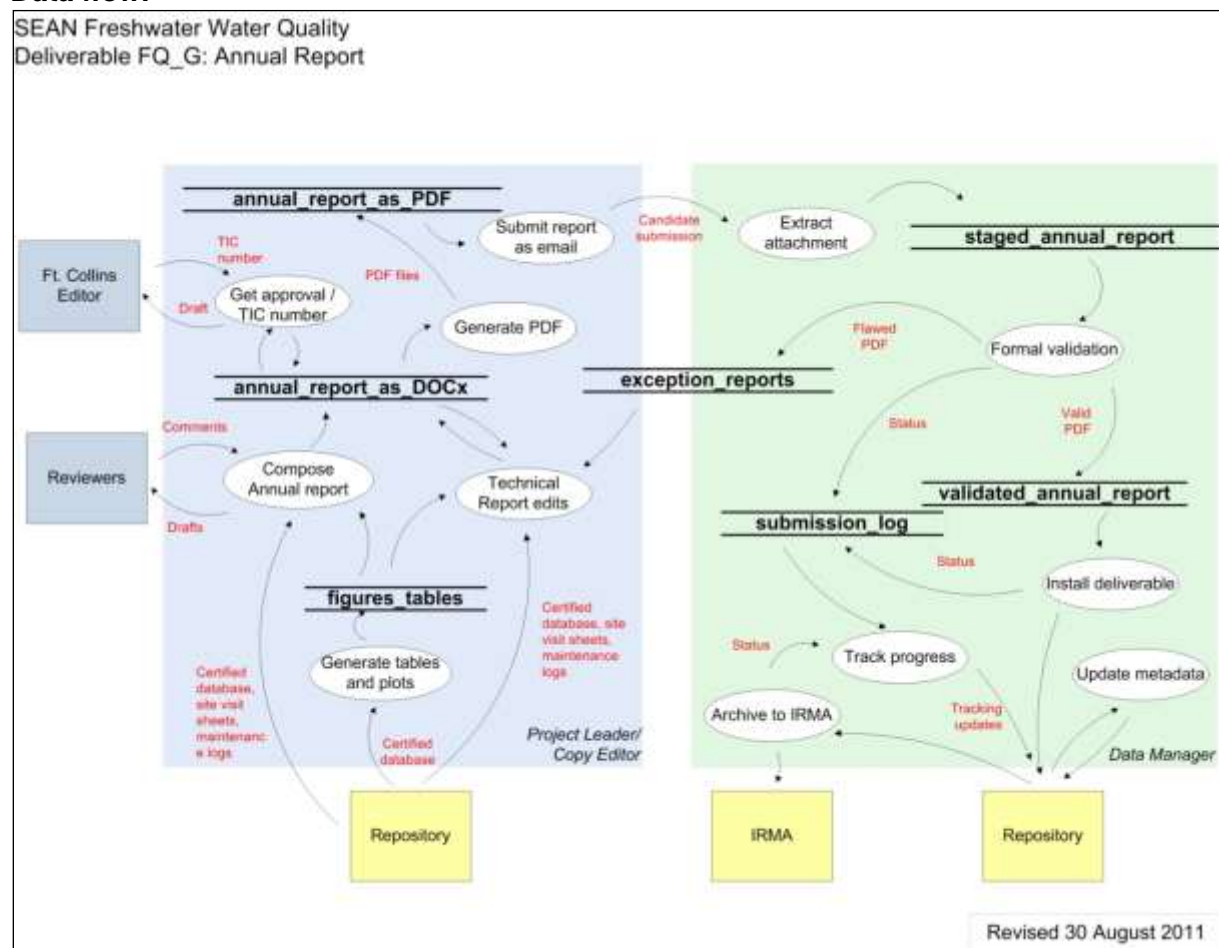


Figure D.7. Data flow required to generate deliverable FQ_G – annual report.

Deliverable definition forms:**Form A: Non-Tabular Information Deliverable**

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Deliverable ID:</i> FQ_G	<i>Deliverable Title:</i> Annual report
<i>File format:</i> PDF and DOCX	<i>Associated software and version:</i> Adobe Reader 9 or later MS Word 2010 or later	<i>Revision date / protocol version:</i> 09-29-2011 / FQ-2013.1
<i>Expected frequency:</i> 1/year	<i>Likely dissemination partners:</i> None – served by SEAN	<i>Submission unit:</i> Year
<i>What purpose does this deliverable serve?</i> Summarizes the operations and outcomes of a season to inform managers, the public, and the community of water quality researchers.		
<i>Summary of content:</i> Synopsis of operations, temporal/spatial coverage for this season, representative data tables, representative data visualizations, discussion summarizing observations.		
<i>Mandatory validation criteria:</i> <ol style="list-style-type: none">1. PDF must successfully open using Adobe Reader 9.0 or greater.2. DOCX must successfully open using Microsoft Word 2010.3. Must be formatted for the NRR report series.4. Must carry an approved TIC number.		
<i>Optional validation criteria:</i> - None -		
<i>Deliverable ID of any other SEAN data products required to create this product</i> FQ_F cumulative database.		
<i>Description and source of any outside data required to create this product:</i> - None -		

D.8 FQ_H: Five-Year Report

Purpose of deliverable: This report discusses trends that are evident from the historic data series. It does not cover operations, which is done in the annual report. The content is appropriate for an audience of management and the public, as well as scientists. It is built in the form of an NPS NRR report.

Frequency produced: These are created every five years, typically sometime after completion of the FQ_G annual report for the most recent season. Circumstances may dictate a longer or shorter frequency.

Prerequisites: Certified database deliverable FQ_F cumulative database for the all seasons in the temporal scope.

Data flow:

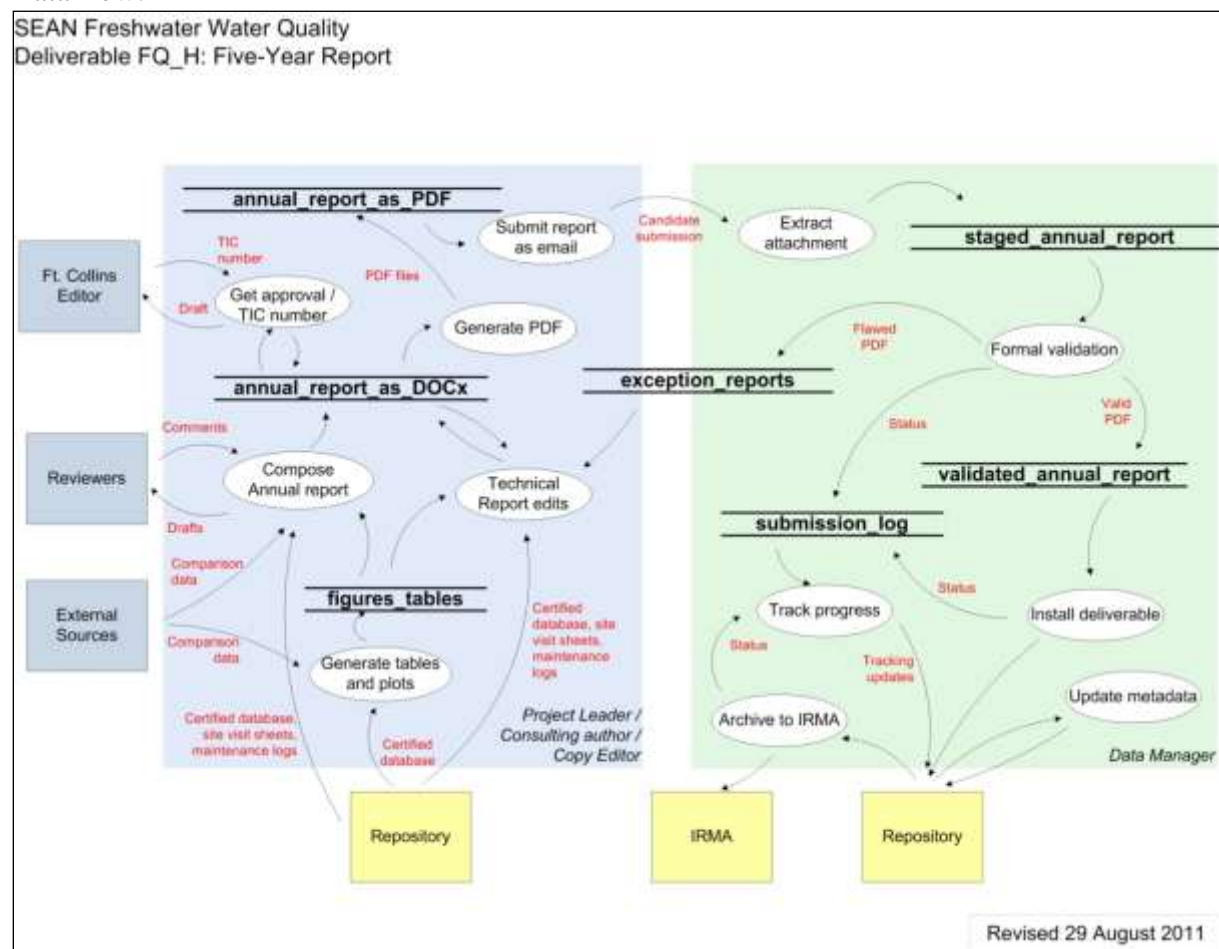


Figure D.7. Data flow required to generate deliverable FQ_H – five-year report.

Deliverable definition forms:

Form A: Non-Tabular Information Deliverable

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Deliverable ID:</i> FQ_H	<i>Deliverable Title:</i> Five-year Report
<i>File format:</i> PDF and DOCX	<i>Associated software and version:</i> Adobe Reader 9 or later MS Word 2010 or later	<i>Revision date / protocol version:</i> 09-29-2011 / FQ-2013.1
<i>Expected frequency:</i> Once every 5 years	<i>Likely dissemination partners:</i> None – served by SEAN	<i>Submission unit:</i> n/a
<i>What purpose does this deliverable serve?</i> Analysis of freshwater water quality levels and trends for each site is provided to inform customers and facilitate decision making. Time series analysis for evaluating cyclic phenomena is presented.		
<i>Summary of content:</i> Introduction, methods, coverage, results, and discussion.		
<i>Mandatory validation criteria:</i> 1. PDF must successfully open using Adobe Reader 9.0 or greater. 2. DOCX must successfully open using Microsoft Word 2010. 3. Must be formatted for the NRR report series. 4. Must carry an approved TIC number.		
<i>Optional validation criteria:</i> - None -		
<i>Deliverable ID of any other SEAN data products required to create this product</i> FQ_F cumulative database.		
<i>Description and source of any outside data required to create this product:</i> Comparison data of other locations obtained from such sources as EPA.		

D.9 FQ_I: NPStoret Submission

Purpose of deliverable: Copies of final certified detailed and summary data are delivered to NPS's water resources division (WRD) for archiving and further dissemination. WRD is responsible for forwarding these data to the EPA Storet national database.

Frequency produced: This is generally created once per field season. In the event incorrect data are discovered in the AOOS system, FQ_I may be recreated at any time to make it whole.

Prerequisites: Production of this deliverable is built using the certified FQ_F database for a particular year.

Data flow:

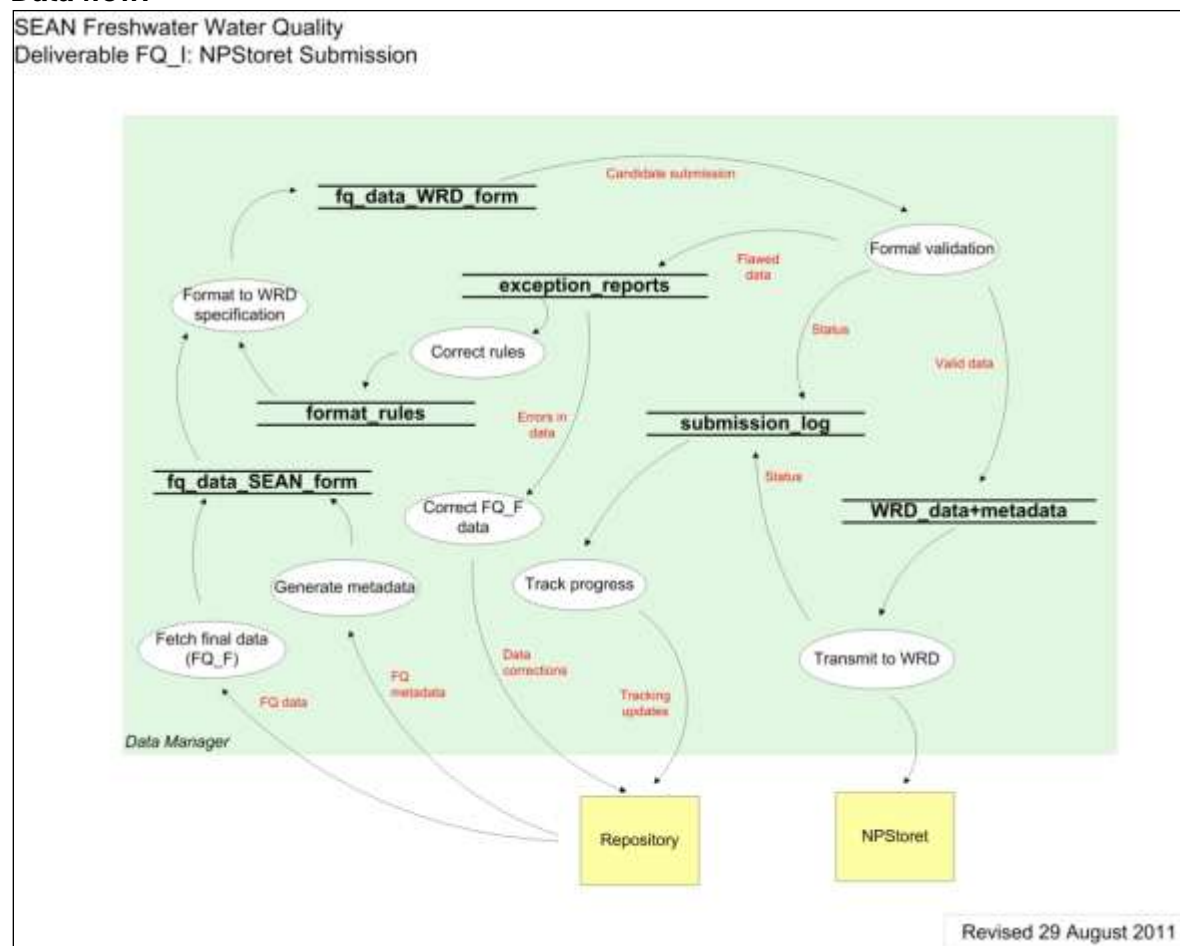


Figure D.9. Data flow required to generate deliverable FQ_I – NPStoret submission.

Deliverable definition forms:

Form D: Tabular Data Deliverable

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Deliverable ID:</i> FQ_I	<i>Deliverable Title:</i> NPStoret submission
<i>File format:</i> n/a	<i>Associated software and version:</i> n/a	<i>Revision Date / protocol version:</i> 08-31-2011 / FQ-2013.1
<i>Expected frequency:</i> 1 submission/year	<i>Likely dissemination partners:</i> None – served by SEAN	<i>Submission unit:</i> YEAR
<i>What purpose does this deliverable serve?</i> Populates secondary repository.		
<i>Identifiers of relations that compose the tabular deliverable (“Relations” are tables or files that provide information which may be represented in a grid format. Each relation listed must be fully defined in its own accompanying Form X.):</i> At the time of this protocol version, NPS Water Resource Division is engaged in a project to wholesale redefine the transmission process of water quality data from I&M Networks to NPStoret. Definition of our final deliverable is suspended until such time as the new WRD specifications and processes are completed.		
<i>Deliverable ID of any other SEAN data products required to create this product:</i> FC_F cumulative database		
<i>Description and source of any outside data required to create this product:</i> Format rules must be supplied by NPS Water Resources Division as a basis for generating the submission file.		

D.10 FQ_J: Processed CSV Data

Purpose of deliverable: ASCII CSV files are generated directly from the proprietary FQ_E raw data product, with additional attributes added from FQ_C site visit worksheets. The resulting CSVs may be read and updated with the many tools that operate on comma separated value files. Building this deliverable allows corrections and flagging to be entered into the data stream by project staff. FQ_J is the basis from which the FQ_F cumulative database is created and updated.

It is noted at the time this protocol is being developed that the NPS Water Resources Division (WRD) is actively defining a comprehensive model workflow for acquiring water quality raw data, performing quality control operations, and moving it to databases. Once that project is complete, it may replace this FQ_J CSV stage without significantly affecting other deliverables. In order to avoid confusing users by disseminating an FQ_J which is expected to be significantly redefined, its access link is temporarily removed from the web site.

Frequency produced: FQ_J is generated at the end of each season after certification of its prerequisite deliverables.

Prerequisites: Production of this deliverable is dependent on certified FQ_C site visit worksheets, FQ_D maintenance records, and FQ_E raw data for the subject year.

Data flow:

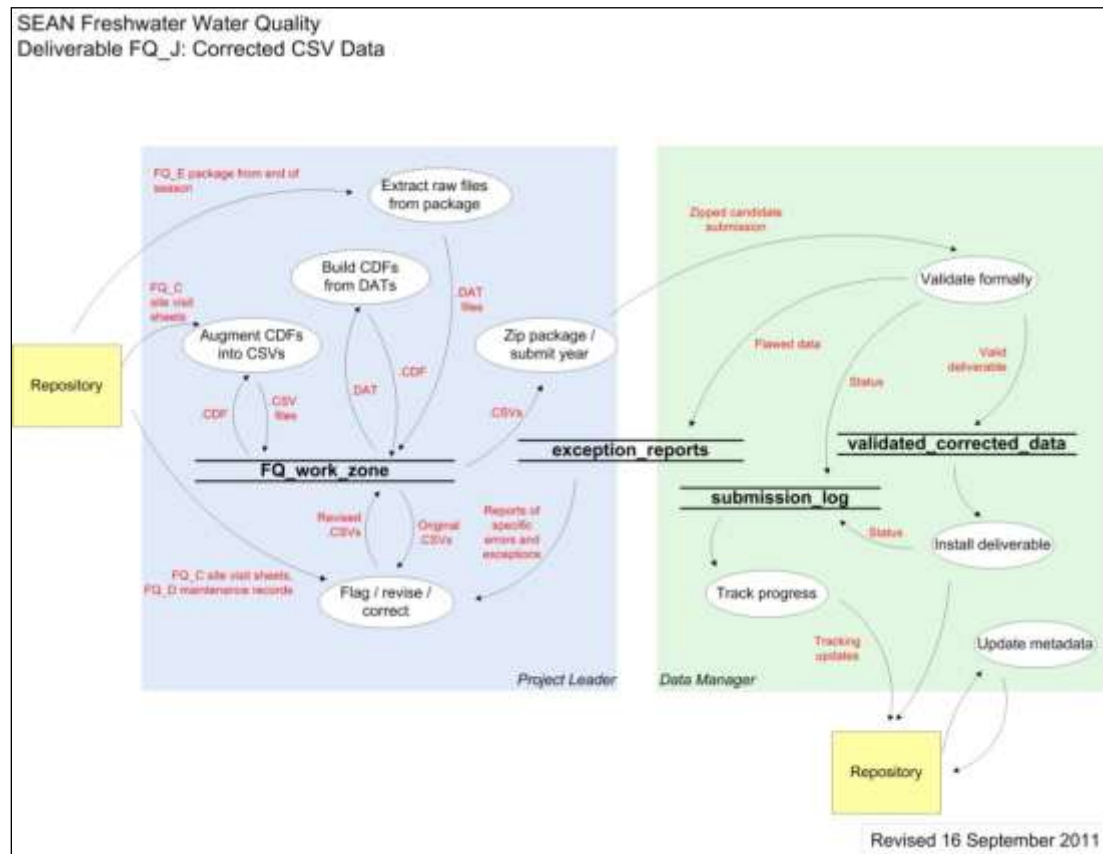


Figure D.10. Data flow required to generate deliverable FQ_J – CSV files.

Deliverable definition forms:

Form D: Tabular Data Deliverable

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Deliverable ID:</i> FQ_J	<i>Deliverable Title:</i> Processed CSV data
<i>File format:</i> “Comma separated value with optional quote” files packaged into a single ZIP file covering the entire year.	<i>Associated software and version:</i> YSI EcoWatch 3.18 for creation. Excel 2010 or similar for editing. WINZIP or similar for packaging.	<i>Revision Date / protocol version:</i> 09-01-2011 / FQ-2013.1
<i>Expected frequency:</i> 1 submission/year of 3 files containing 4,000 rows each.	<i>Likely dissemination partners:</i> None – served by SEAN	<i>Submission unit:</i> YEAR
<i>What purpose does this deliverable serve?</i> Converts proprietary FQ_E sonde data into a readily readable form. Houses quality control information, data flagging, and error correction. Serves as the basis for populating the FQ_F database.		
<i>Identifiers of relations that compose the tabular deliverable (“Relations” are tables or files that provide information which may be represented in a grid format. Each relation listed must be fully defined in its own accompanying Form X.):</i> FQ_J_yyyy.ZIP, where “yyyy” denotes the year covered, is the deliverable package file. Within the ZIP are individual files named FQ_J_site_yyyy.CSV, where “site” is the formal site code and “yyyy” is the subject year. Note there is only one site CSV file per year, regardless of how many times a site’s DAT file was captured during the season.		
<i>Deliverable ID of any other SEAN data products required to create this product:</i> FQ_E for the underlying sonde raw data. FQ_C site visit sheets for data grading. FQ_D maintenance logs for resolving QC issues.		
<i>Description and source of any outside data required to create this product:</i> - none -		

Form X: Relation Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Relation identifier:</i> FQ_J_site_yyyy.CSV	<i>Used by deliverable ID:</i> FQ_J																																				
<i>Revision Date / protocol version:</i> 09-01-2011 / FQ-2013.1	<i>Type of relation:</i> Data file	<i>Estimated rows:</i> 4,000																																				
<i>Natural primary key for this relation:</i> date_local + time_local + site																																						
<i>Purpose:</i> Freshwater water quality instrument readings taken at periodic intervals in multiple locations. The file consists of a single header row of proscribed form that labels the data columns. This is followed by rows of hourly observations and related data.																																						
<i>Identifiers of attributes defined over this relation (“Attributes” are columns of the grid. Each attribute must be defined in an accompanying Form Y.):</i> <table border="1"> <tr><td>DATE_LOCAL</td><td>TIME_LOCAL</td></tr> <tr><td>PARK</td><td>SITE</td></tr> <tr><td>LATITUDE</td><td>LONGITUDE</td></tr> <tr><td>SONDE_SN</td><td>RECORDER</td></tr> <tr><td>TEMPERATURE</td><td>TEMP_RECORD_QUALITY</td></tr> <tr><td>TEMP_DATA_GRADE</td><td>TEMP_OUTLIER</td></tr> <tr><td>TEMP_QUALITY_COMMENT</td><td>CONDUCTIVITY</td></tr> <tr><td>COND_RECORD_QUALITY</td><td>COND_DATA_GRADE</td></tr> <tr><td>COND_OUTLIER</td><td>COND_QUALITY_COMMENT</td></tr> <tr><td>PH</td><td>PH_RECORD_QUALITY</td></tr> <tr><td>PH_DATA_GRADE</td><td>PH_OUTLIER</td></tr> <tr><td>PH_QUALITY_COMMENT</td><td>DO_CONCENTRATION</td></tr> <tr><td>DO_RECORD_QUALITY</td><td>DO_DATA_GRADE</td></tr> <tr><td>DO_OUTLIER</td><td>DO_QUALITY_COMMENT</td></tr> <tr><td>TURBIDITY</td><td>TURB_RECORD_QUALITY</td></tr> <tr><td>TURB_DATA_GRADE</td><td>TURB_OUTLIER</td></tr> <tr><td>TURB_QUALITY_COMMENT</td><td>DO_PERCENT</td></tr> <tr><td>PROTOCOL_ID</td><td>COMMENTS</td></tr> </table>			DATE_LOCAL	TIME_LOCAL	PARK	SITE	LATITUDE	LONGITUDE	SONDE_SN	RECORDER	TEMPERATURE	TEMP_RECORD_QUALITY	TEMP_DATA_GRADE	TEMP_OUTLIER	TEMP_QUALITY_COMMENT	CONDUCTIVITY	COND_RECORD_QUALITY	COND_DATA_GRADE	COND_OUTLIER	COND_QUALITY_COMMENT	PH	PH_RECORD_QUALITY	PH_DATA_GRADE	PH_OUTLIER	PH_QUALITY_COMMENT	DO_CONCENTRATION	DO_RECORD_QUALITY	DO_DATA_GRADE	DO_OUTLIER	DO_QUALITY_COMMENT	TURBIDITY	TURB_RECORD_QUALITY	TURB_DATA_GRADE	TURB_OUTLIER	TURB_QUALITY_COMMENT	DO_PERCENT	PROTOCOL_ID	COMMENTS
DATE_LOCAL	TIME_LOCAL																																					
PARK	SITE																																					
LATITUDE	LONGITUDE																																					
SONDE_SN	RECORDER																																					
TEMPERATURE	TEMP_RECORD_QUALITY																																					
TEMP_DATA_GRADE	TEMP_OUTLIER																																					
TEMP_QUALITY_COMMENT	CONDUCTIVITY																																					
COND_RECORD_QUALITY	COND_DATA_GRADE																																					
COND_OUTLIER	COND_QUALITY_COMMENT																																					
PH	PH_RECORD_QUALITY																																					
PH_DATA_GRADE	PH_OUTLIER																																					
PH_QUALITY_COMMENT	DO_CONCENTRATION																																					
DO_RECORD_QUALITY	DO_DATA_GRADE																																					
DO_OUTLIER	DO_QUALITY_COMMENT																																					
TURBIDITY	TURB_RECORD_QUALITY																																					
TURB_DATA_GRADE	TURB_OUTLIER																																					
TURB_QUALITY_COMMENT	DO_PERCENT																																					
PROTOCOL_ID	COMMENTS																																					
<i>Mandatory validation criteria involving multiple attributes:</i> A parameter’s record quality flag may be null only if its quality comment is also null.																																						
<i>Optional validation criteria involving multiple attributes:</i> Date_local should have a year consistent with the year embedded in the filename.																																						

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DATE_LOCAL	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-01-2011 / FQ-2013.1	<i>Default report heading:</i> DATE	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> The date a particular set of readings were recorded. Time zone is always GMT-8, which corresponds to Alaska Daylight Time.		
<i>Data type:</i>	date	
<i>Maximum length</i>	n/a	
<i>Required:</i>	YES	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must be a valid date. 2. Must not be a date beyond the current one at point of validation. 3. Must not be a date before 2010.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TIME_LOCAL	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-01-2011 / FQ-2013.1	<i>Default report heading:</i> TIME	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> The time a particular set of readings were recorded. Time zone is always GMT-8, which corresponds to Alaska Daylight Time.		
<i>Data type:</i>	time	
<i>Maximum length</i>	n/a	
<i>Required:</i>	YES	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must be a valid time.	
<i>Optional validation rules for this attribute:</i>		

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PARK	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-01-2011 / FQ-2013.1	<i>Default report heading:</i> PARK	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> The NPS unit ID for the park in which the observation site is located. This attribute is assigned when the CSV file is initially created as detailed in SOP 13.		
<i>Data type:</i>	Varchar(4)	
<i>Maximum length</i>	4	
<i>Required:</i>	yes	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must be one of GLBA, KLGO, SITK.	
<i>Optional validation rules for this attribute:</i>	Should correspond with SITE.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> SITE	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-01-2011 / FQ-2013.1	<i>Default report heading:</i> SITE	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> The coded site where the sonde was located when the readings were recorded. This attribute is assigned when the CSV file is initially created as detailed in SOP 13.		
<i>Data type:</i>	Varchar(4)	
<i>Maximum length</i>	4	
<i>Required:</i>	yes	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	any	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must be one of IN, SA, TA.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> LATITUDE	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-01-2011 / FQ-2013.1	<i>Default report heading:</i> LATITUDE	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Decimal latitude using the WGS84 datum. This attribute is assigned when the CSV file is initially created as detailed in SOP 13.		
<i>Data type:</i>	real	
<i>Maximum length</i>	8	
<i>Required:</i>	no	
<i>Measurement units:</i>	degrees	
<i>Format:</i>	99.99999	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must be a real number.	
<i>Optional validation rules for this attribute:</i>	Should be between 57.0 and 61.0.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> LONGITUDE	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-01-2011 / FQ-2013.1	<i>Default report heading:</i> LONGITUDE	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Decimal longitude using the WGS84 datum. This attribute is assigned when the CSV file is initially created as detailed in SOP 13.		
<i>Data type:</i>	real	
<i>Maximum length</i>	10	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	-999.99999	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must be a real number.	
<i>Optional validation rules for this attribute:</i>	Should be between -135.0 and -142.0.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> SONDE_SN	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-01-2011 / FQ-2013.1	<i>Default report heading:</i> SONDE SERIAL#	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Uniquely identifies the sonde used for particular readings. The manufacturer's serial number is used for this purpose. This attribute is assigned when the CSV file is initially created as detailed in SOP 13.		
<i>Data type:</i>	Varchar(32)	
<i>Maximum length</i>	32	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must not exceed maximum length.	
<i>Optional validation rules for this attribute:</i>	1. Should be present	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> RECORDER	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-01-2011 / FQ-2013.1	<i>Default report heading:</i> RECORDER	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Name of the field person who collected the particular raw data file this row is based on. This attribute is assigned when the CSV file is initially created as detailed in SOP 13.		
<i>Data type:</i>	Varchar(32)	
<i>Maximum length</i>	32	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	- none -	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TEMPERATURE	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-01-2011 / FQ-2013.1	<i>Default report heading:</i> Temperature (°C)	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Water temperature in degrees Celsius as reported by sonde.		
<i>Data type:</i>	Real	
<i>Maximum length</i>	6	
<i>Required:</i>	no	
<i>Measurement units:</i>	Degrees C	
<i>Format:</i>	99.999	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	12. Must be a real number < 100.0.	
<i>Optional validation rules for this attribute:</i>	1. Should be between 0.0 and 20.0	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TEMP_RECORD_QUALITY	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Temperature Record Quality	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Indicator of the quality of the temperature observation, for determining whether to include it in analyses: 0=good (the default), 1=unknown (no site visit sheet), 2=questionable (inconsistent sensor readings, exception noted on log sheet), 3=bad (dead sensor, failing battery, scrambled DAT file, sonde physically damaged, washout, sonde out of water). This attribute is added to the file as empty when the CSV file is initially created as detailed in SOP 13 and is to be given a value as part of completing deliverable FQ_J.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match 0, 1, 2, or 3.	
<i>Optional validation rules for this attribute:</i>	1. Should be present if TEMPERATURE is present.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TEMP_DATA_GRADE	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Temperature Data Grade	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> A code signifying data grade based on the criteria detailed in SOP 2. E=excellent, G=good, F=fair, P=poor. It is only present when TEMP_RECORD_QUALITY = 0.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match E, G, F, or P. 2. Must be present if and only if TEMP_RECORD_QUALITY=0.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TEMP_OUTLIER	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Temperature Outlier	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Assigned the value 'Y' if and only if the Project Leader judges TEMPERATURE to be a data outlier.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	Upper	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must be 'Y'.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TEMP_QUALITY_COMMENT	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Temperature Comment	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Explanation of why record quality for temperature was not considered “good.” This attribute was added to the file as empty when the CSV file was initially created as detailed in SOP 13 and is to be given a value as part of completing deliverable FQ_J.		
<i>Data type:</i>	Varchar(512)	
<i>Maximum length</i>	512	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	- none -	
<i>Optional validation rules for this attribute:</i>	1. Should be present if TEMP_RECORD_QUALITY > 0.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> CONDUCTIVITY	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Conductivity (mS/cm)	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Conductivity in milliSiemens/centimeter as reported by sonde.		
<i>Data type:</i>	Real	
<i>Maximum length</i>	6	
<i>Required:</i>	no	
<i>Measurement units:</i>	mSiemens/cm	
<i>Format:</i>	9.9999	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	13. Must be a real number between 0.0 and 9.9999.	
<i>Optional validation rules for this attribute:</i>	1. Should be between 0.0 and 2.0.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> COND_RECORD_QUALITY	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Conductivity Record Quality	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Indicator of the quality of the conductivity observation, for determining whether to include it in analyses: 0=good (the default), 1=unknown (no site visit sheet), 2=questionable (inconsistent sensor readings, exception noted on log sheet), 3=bad (dead sensor, failing battery, scrambled DAT file, sonde physically damaged, washout, sonde out of water). This attribute is added to the file as empty when the CSV file is initially created as detailed in SOP 13 and is to be given a value as part of completing deliverable FQ_J.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match 0, 1, 2, or 3.	
<i>Optional validation rules for this attribute:</i>	1. Should be present if CONDUCTIVITY is present.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> COND_DATA_GRADE	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Conductivity Data Grade	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> A code signifying data grade based on the criteria detailed in SOP 2. E=excellent, G=good, F=fair, P=poor. It is only present when COND_RECORD_QUALITY = 0.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match E, G, F, or P. 2. Must be present if and only if COND_RECORD_QUALITY=0.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> COND_OUTLIER	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Conductivity Outlier	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Assigned the value ‘Y’ if and only if the Project Leader judges CONDUCTIVITY to be a data outlier.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	Upper	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must be ‘Y’.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> COND_QUALITY_COMMENT	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Conductivity Comment	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Explanation of why record quality for conductivity was not considered “good.” This attribute was added to the file as empty when the CSV file was initially created as detailed in SOP 13 and is to be given a value as part of completing deliverable FQ_J.		
<i>Data type:</i>	Varchar(512)	
<i>Maximum length</i>	512	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	- none -	
<i>Optional validation rules for this attribute:</i>	1. Should be present if COND_RECORD_QUALITY > 0.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PH	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> pH	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> pH of water as reported by sonde.		
<i>Data type:</i>	Real	
<i>Maximum length</i>	6	
<i>Required:</i>	no	
<i>Measurement units:</i>	pH units	
<i>Format:</i>	99.000	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	14. Must be a real number between 1.0 and 12.0.	
<i>Optional validation rules for this attribute:</i>	1. Should be between 5.0 and 10.0	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PH_RECORD_QUALITY	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> pH Record Quality	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Indicator of the quality of the pH observation, for determining whether to include it in analyses: 0=good (the default), 1=unknown (no site visit sheet), 2=questionable (inconsistent sensor readings, exception noted on log sheet), 3=bad (dead sensor, failing battery, scrambled DAT file, sonde physically damaged, washout, sonde out of water). This attribute is added to the file as empty when the CSV file is initially created as detailed in SOP 13 and is to be given a value as part of completing deliverable FQ_J.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match 0, 1, 2, or 3.	
<i>Optional validation rules for this attribute:</i>	1. Should be present if PH is present.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PH_DATA_GRADE	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> pH Data Grade	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> A code signifying data grade based on the criteria detailed in SOP 2. E=excellent, G=good, F=fair, P=poor. It is only present when PH_RECORD_QUALITY = 0.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match E, G, F, or P. 2. Must be present if and only if PH_RECORD_QUALITY=0.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PH_OUTLIER	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> pH Outlier	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Assigned the value 'Y' if and only if the Project Leader judges PH to be a data outlier.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	Upper	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must be 'Y'.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PH_QUALITY_COMMENT	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> pH Comment	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Explanation of why record quality for pH was not considered “good.” This attribute was added to the file as empty when the CSV file was initially created as detailed in SOP 13 and is to be given a value as part of completing deliverable FQ_J.		
<i>Data type:</i>	Varchar(512)	
<i>Maximum length</i>	512	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	- none -	
<i>Optional validation rules for this attribute:</i>	1. Should be present if PH_RECORD_QUALITY > 0.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DO_CONCENTRATION	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-01-2011 / FQ-2013.1	<i>Default report heading:</i> Dissolved Oxygen	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Dissolved oxygen concentration in milligrams per liter as reported by sonde..		
<i>Data type:</i>	Real	
<i>Maximum length</i>	6	
<i>Required:</i>	no	
<i>Measurement units:</i>	Mg/L	
<i>Format:</i>	99.999	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	15. Must be a real number between 0.0 and 99.999.	
<i>Optional validation rules for this attribute:</i>	1. Should be between 1.0 and 18.0	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DO_RECORD_QUALITY	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Oxygen Concentration Quality	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Indicator of the quality of the DO observation, for determining whether to include it in analyses: 0=good (the default), 1=unknown (no site visit sheet), 2=questionable (inconsistent sensor readings, exception noted on log sheet), 3=bad (dead sensor, failing battery, scrambled DAT file, sonde physically damaged, washout, sonde out of water). This attribute is added to the file as empty when the CSV file is initially created as detailed in SOP 13 and is to be given a value as part of completing deliverable FQ_J.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match 0, 1, 2, or 3.	
<i>Optional validation rules for this attribute:</i>	1. Should be present if DO_CONCENTRATION is present.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DO_DATA_GRADE	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Oxygen Data Grade	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> A code signifying data grade based on the criteria detailed in SOP 2. E=excellent, G=good, F=fair, P=poor. It is only present when DO_RECORD_QUALITY = 0.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match E, G, F, or P. 2. Must be present if and only if DO_RECORD_QUALITY=0.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DO_OUTLIER	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Oxygen Outlier	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Assigned the value 'Y' if and only if the Project Leader judges DO_CONCENTRATION to be a data outlier. ⁷		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	Upper	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must be 'Y'.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DO_QUALITY_COMMENT	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Oxygen Comment	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Explanation of why record quality for pH was not considered "good." This attribute was added to the file as empty when the CSV file was initially created as detailed in SOP 13 and is to be given a value as part of completing deliverable FQ_J.		
<i>Data type:</i>	Varchar(512)	
<i>Maximum length</i>	512	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	- none -	
<i>Optional validation rules for this attribute:</i>	1. Should be present if DO_RECORD_QUALITY > 0.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TURBIDITY	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Turbidity (NTU)	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Relative measure of suspended solids expressed in NTUs as reported by sonde.		
<i>Data type:</i>	Real	
<i>Maximum length</i>	6	
<i>Required:</i>	no	
<i>Measurement units:</i>	NTU	
<i>Format:</i>	999.99	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	16. Must be a real number. 17. Must be between 0.0 and 999.99.	
<i>Optional validation rules for this attribute:</i>	1. Should be between 0.0 and 300.0	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TURB_RECORD_QUALITY	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Turbidity Quality	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Indicator of the quality of the TURBIDITY observation, for determining whether to include it in analyses: 0=good (the default), 1=unknown (no site visit sheet), 2=questionable (inconsistent sensor readings, exception noted on log sheet), 3=bad (dead sensor, failing battery, scrambled DAT file, sonde physically damaged, washout, sonde out of water). This attribute is added to the file as empty when the CSV file is initially created as detailed in SOP 13 and is to be given a value as part of completing deliverable FQ_J.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match 0, 1, 2, or 3.	
<i>Optional validation rules for this attribute:</i>	1. Should be present if TURBIDITY is present.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TURB_DATA_GRADE	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Turbidity Data Grade	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> A code signifying data grade based on the criteria detailed in SOP 2. E=excellent, G=good, F=fair, P=poor. It is only present when TURB_RECORD_QUALITY = 0.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must match E, G, F, or P. 2. Must be present if and only if TURB_RECORD_QUALITY=0.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TURB_OUTLIER	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Turbidity Outlier	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Assigned the value 'Y' if and only if the Project Leader judges TURBIDITY to be a data outlier.		
<i>Data type:</i>	Varchar(1)	
<i>Maximum length</i>	1	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	Upper	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. If present, must be 'Y'.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> TURB_QUALITY_COMMENT	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Turbidity Comment	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Explanation of why record quality for turbidity was not considered “good.” This attribute was added to the file as empty when the CSV file was initially created as detailed in SOP 13 and is to be given a value as part of completing deliverable FQ_J.		
<i>Data type:</i>	Varchar(512)	
<i>Maximum length</i>	512	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	- none -	
<i>Optional validation rules for this attribute:</i>	1. Should be present if TURB_RECORD_QUALITY > 0.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> DO_PERCENT	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Oxygen Saturation (%)	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Dissolved oxygen saturation as percent as reported by sonde.		
<i>Data type:</i>	Real	
<i>Maximum length</i>	7	
<i>Required:</i>	no	
<i>Measurement units:</i>	%	
<i>Format:</i>	999.999	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	18. Must be a real number. 19. Must be between 0.0 and 130.0.	
<i>Optional validation rules for this attribute:</i>	1. Should be between 35.0 and 110.0.	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> PROTOCOL_ID	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-15-2011 / FQ-2013.1	<i>Default report heading:</i> Protocol	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> The formal version of the protocol under which this row was created. This attribute is assigned when the CSV file is initially created as detailed in SOP 13.		
<i>Data type:</i>	Varchar(10)	
<i>Maximum length</i>	10	
<i>Required:</i>	yes	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>		
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	1. Must match the formal designator of the protocol used to acquire these data. 2. One consistent value must be used throughout the file.	
<i>Optional validation rules for this attribute:</i>	- none -	

Form Y: Attribute Definition

<i>Vital Sign:</i> FQ Freshwater water quality	<i>Attribute identifier:</i> COMMENTS	<i>Used by deliverable ID:</i> FQ_J
<i>Revision date / protocol version:</i> 09-01-2011 / FQ-2013.1	<i>Default report heading:</i> Comments	<i>Relation (from Form X):</i> FQ_J_site_yyyy.CSV
<i>Purpose:</i> Recorded comments regarding circumstances of this particular set of contemporaneous observations. This attribute was added to the file as empty when the CSV file was initially created as detailed in SOP 13 and may optionally be given a value as part of completing deliverable FQ_J.		
<i>Data type:</i>	Varchar(1024)	
<i>Maximum length</i>	1024	
<i>Required:</i>	no	
<i>Measurement units:</i>	n/a	
<i>Format:</i>	n/a	
<i>Foreign key to (relation+attribute):</i>	n/a	
<i>Case:</i>	n/a	
<i>Mandatory validation rules for this attribute (in order of application):</i>	- none -	
<i>Optional validation rules for this attribute:</i>	- none -	

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 953/120490, April 2013

National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science

1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov

EXPERIENCE YOUR AMERICA™